PHILOSOPHY OF SCIENCE
IN RELATION TO CURRICULAR AND PEDAGOGICAL ISSUES:
A study of science teachers' opinions and their implications.

by

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ABSTRACT

This study sought to capture how science teachers view scientific knowledge from a philosophical-epistemological perspective. The philosophical themes investigated were scientific method, criteria of demarcation, patterns of scientific change and problems related with the construction of reality. Furthermore, an attempt was made to investigate the relation teachers' views on these matters both to certain curricular issues (the question of integration and the meaning of the terms "content" and "process") and to some pedagogical issues (assumptions about learning, instruction and aspects of classroom activities).

For this purpose, a framework was proposed for the analysis of the relevant issues. This framework consists of a number of distinctions. These distinctions were organised employing the technique of systemic network analysis, so as to lay the basis not only for the construction of the research instrument but also for the analysis of the empirical evidence. The epistemological systems taken into account in the a-priori analysis are: inductivism, hypothetico-deductivism (Popper, Lakatos), contextualism (Kuhn) and relativism (Feyerabend). At the ontological level, the contrast is mainly focused on the differences between idealism and realism (pragmatism is also included).

Three stages can be distinguished in the analysis of the data. The first stage is a systematic description of the data and shows that the dominant pattern in teachers' philosophical and epistemological views tends to be close to contextualism. It indicates that teachers tend to prefer the introduction of integrated science curricula, and in terms of pedagogy, to stress pupils ability to think in abstract terms, as well as to emphasise a teacher-centred approach. In the second stage, a classification of responses into distinct categories (i.e. inductivism, relativism, etc.) was made on the basis of each individual following consistently a particular path of the network. The outcome suggests that indeed the Kuhnian system of thought is favoured consistently more than any other system. The third stage is an analysis of the correlations of teachers' views within and across the three components (philosophical, curricular and pedagogical). On the basis of this analysis, a tentative conclusion is that there are two relatively autonomous regions of "educational theory" as held by teachers, namely epistemological and pedagogical views on the one hand and ontological and curricular views on the other.

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I.1 Rationale and delineation of the questions.

> ... which is to say that even in the handling of practical things, be they agriculture, mechanics or the governing of a city, a kind of philosophy is required.
> U. ECCO (The name of the Rose).

For one to assert that even practical activities need a philosophy is a truism for some, whilst for others, it sounds like, if not a paradox, a form of eccentricity or self-indulgence.

Nevertheless this thesis sets out to investigate science teachers' beliefs about issues concerning the philosophical-epistemological basis of science teaching and its relation to certain curricular and pedagogical issues.

In an attempt to meet such misgivings (and even if doing so resembles a petition to the impossible), one has to confront three questions:

-is it legitimate, and if so is it helpful to question not only the kind of science to be taught in schools (content), but also the way science is taught (pedagogy) in the light of a philosophical analysis of scientific knowledge?

-have the analyses of scientific knowledge, along philosophical and/or sociological lines made within these respective fields, been applied or can they be applied by educators?

-why are teachers views on the relevant issues of any significance?

In so far as the first question is concerned, there would seem to be a considerable number of questions about science which are pertinent to science teaching. For instance, are notions like truth, objectivity, rationality, reality (and real) worth dealing with in the context of science education? Is there only one scientific method, or many? What is its/their relationship with the above mentioned notions (if any)? Is there (or should there be) any distinction between theory and observation? Why and in what sense? Is the body of scientific knowledge different from other sorts of knowledge? If so, how? Is it because scientific knowledge has special claims on notions like truth and/or objectivity? Why could scientific knowledge be seen as having these special claims? Is it because it reflects reality? Or, is scientific knowledge just a construct (social or personal) no different from any other system of organised thought (eg. novels, myths)? In either case, is it meaningful to search for criteria of demarcating scentific knowledge from other forms of knowledge or from knowledge which poses as scientific? Could one define such criteria? Is there a definite pattern of scientific change? Should this change be considered as growth or progress? And, is this growth (if any) cumulative or what else? Finally, how are all these questions interwoven, and what are the different philosophical systems which emerge from different answers to them?

Clearly, it is one thing to state such questions, but it is something else to discuss them and yet another to justify their relevance to science education. The last point is the object of the following section, while the subsequent chapters II and III will focus on a discussion of the questions themselves.

It is argued here, that these questions are relevant to the teaching of science because philosophical considerations have several implications for a number of practically significant issues in science education. In other words, despite the fact that the whole enterprise of philosophy of science cannot be regarded as finished or certain, nevertheless it can cast light on and be useful if not to science proper then surely to science education.

In this vein, Robinson [1] argues that teachers' conception of the "nature of science" is an important force in shaping classroom behaviour. In his paper he gives a number of examples to substantiate his position. One can get an impression of the degree of significance of philosophical considerations for the teaching of science by sampling one. To the question "what is a gene?" does the teacher's explanation reflect the construct 'gene' or does his language reify the construct and makes it into an entity? (i.e. is gene given instrumental or existential status)? Furthermore, "in relating DNA to inheritance does the verbal discourse include construction of a physical model that accounted for certain experimental data? Does it include the generative qualities of such models in the sciences that have made the DNA model productive of hypotheses that could not have been formulated in the absence of the model?" Or, does teacher's consideration treats DNA as a factual entity?

If however, Robinson has been the pioneer in the field, it is Scheffler who has produced the most convincing argument for the relevance of philosophical-epistemological considerations to science teaching. The thrust of this argument is that the educator taking on the responsibility of educational transmission, assumes the obligation of evaluating whatever there is in that tradition he chooses to perpetuate. "For the educator is constantly in the position, not only of representing and advancing specialised exemplifications of thought, but also of explaining and interpreting such exemplifications to the novice" [2]. In this transitional role, philosophy of science is of primary importance. To this, one could counter-argue that philosophy of science does not provide the teacher with firmly established views but rather with an array of sometimes incompatible positions. However, in Scheffler's words "this array, although it does not fix his direction, liberates him from the dogmatism of ignorance, gives him a realistic apprehension of alternatives and outlines relevant considerations that have been elaborated in the history of the problem" (Scheffler, p.216).

Turning now to the second question originally posed, the various philosophical and sociological schools of thought look at the same sorts of problems from different angles, because of their different presuppositions and preoccupations. It is therefore reasonable to expect that they will yield different and sometimes contradictory answers, in addition to offering different methodological frameworks for analysing the same problems. This being explicable, does not cancel either the inevitable fragmentation or the frustration experienced by an educator when seeking for help. On the other hand, it should be admitted that as Scheffler argues, educational research focuses mainly on what is called educational philosophy, making scant use of the philosophies of the relevant subject (i.e. science) in a systematic way, even when, as a growing body of literature concerning the importance of children's prior knowledge to science teaching indicates, epistemological assumptions are often used as starting points.

Robinson [3], commenting in 1969 on this situation argues that "... science education lacked well-developed philosophical starting points and has tended to be contradictory, fragmented and unpatterned ... teaching and learning studies have appropriated 'methods' of science, scientific 'principles', science concepts etc. as unexamined starting points". Six years later Smolicz and Nunan [4], reviewing Robinson's ideas, appear to share his worries: "A possible explanation for this neglect of philosophical starting points can be offered. Science educators may be simply naive and unaware of diverse view points, or alternatively through their own scientific education, embrace the values of a particular model to which they have become committed".

Considerable empirical work has been done on teachers' views about philosophical issues [5]. However, the main reason why the present survey was thought worth undertaking, is that previous studies have been constructed as to take into account generally only one or two philosophical traditions and very often tend to lack the articulation of the philosophical with the curricular and the pedagogical element. A more detailed overview and critique of the relevant literature is presented in chapter VI.

As already stated this thesis represents an attempt to address the problem through an analysis of scientific knowledge along philosophical-epistemological lines and to discuss the outcome of such an analysis in relation to certain curricular and pedagogical issues. Furthermore, an exploration of teachers' relevant views and their correlation with teachers' curricular and "pedagogical" assumptions will be investigated in order to pinpoint contingent areas of educational "theory", as held by teachers.

Teachers' assumptions concerning the philosophical dimensions of scientific knowledge and its relationship to science curriculum and pedagogy cannot be assumed to be clear-cut and absolutely coherent stances. Since even professional philosophers dispute each other's coherence of viewpoint, it is not unreasonable to assume that teachers' views are not absolutely consistent. This assumption however, is not particularly problematic as it is testable, i.e. the instrument (which can be used as a tool to map science teachers' philosophical, curricular and pedagogical views) can assist in the detection of contingent tensions (within each and across these domains).

Finally, a discussion about curricular and pedagogical views in the light of prevailing philosophical stances will be presented, thereby serving to establish a tentative image of part of the educational "theory" which a certain group of science teachers hold.

There is one point which needs clarification here. Using the term "theory" in this context it is not to say that theory and practice can be dichotomised into separate and distinct categories [6]. On the contrary, I would suggest that this study should be followed by further work in which the congruence of the practice with the "theory" established would be investigated.

In the present work, teachers' responses will be compared with a number of philosophical and other stances considered to be of contemporary importance, no one philosophical, curricular or pedagogical stance being considered to be the "correct" one. This is not to assert that there is no "correct" stance but that so far as identifying teachers' positions is concerned, it is necessary to withhold judgement about their validity.

There potentially exist further kinds of use of the instrument developed in the study which extend beyond its present purposes. For instance, it could serve as a source of information for curriculum designers and developers. In this respect, Havelock [7], in discussing models of curriculum innovation, has argued for the need of the innovating centre to know the dispositions of teachers. Others (e.g. Stenhouse [8]), disputing the value of centre-oriented innovation, have pointed to the failure of the central group on some occasions to take into account teachers views. Obviously, an instrument capable of recording aspects of teachers' views could be of help in removing this sort of tension.

Furthermore, the application of the instrument could be seen as one possible prerequisite for helping to establish interdepartamental liaison, as for instance Hart, Boath and Turner [9], as well as Selkirk [10] suggest is essential for science and mathematics departments. The basis for this claim is that knowledge of others philosophical assumptions regarding scientific knowledge, as well as their views on certain pedagogical issues, and the science school curricula could only help. However, the point here, is not to explore all potentially useful areas for application of the instrument. It is intended merely to point out that there are some other areas too, where the application of the instrument could be of help.

I.2 The overall research plan.

Having outlined in the previous section the main aims of the study, the stages in the process of implementing these as well as the overall structure of the thesis will be presented next (including their diagrammatic representations).

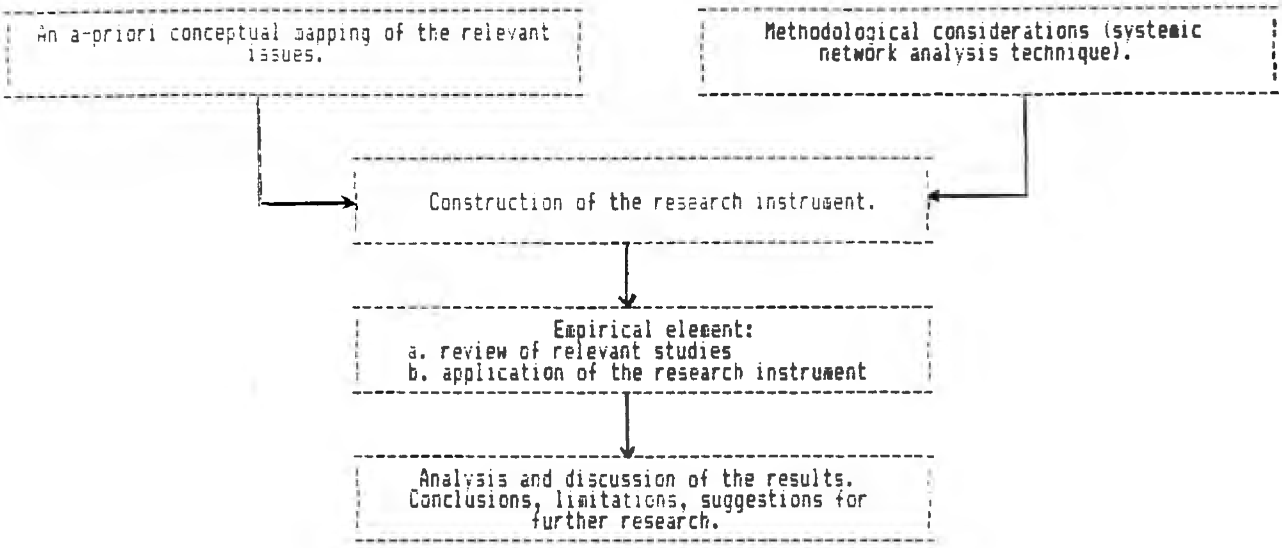


DIAGRAM DI.1: The stages of the research.

An a-priori analysis of scientific knowledge along philosophical -epistemological lines as well as a discussion of certain curricular issues (i.e. the question of integrated science and the meaning of content and process in science) and pedagogical issues (i.e. general assumptions about learning, instruction and classroom activities) constitute the first stage.

It should be noted here that the balance concerning the discussion between on the one hand the philosophical-epistemological issues and the curricular and pedagogical ones on the other, is itentionally. given the general orientation of this study, not even.

The second stage deals with the methodological approach, more specifically the systemic network analysis technique in relation to general methodological considerations and theory of knowledge. The construction of the research instrument (which is based on the two previous stages) constitutes the third stage. The fourth stage consists

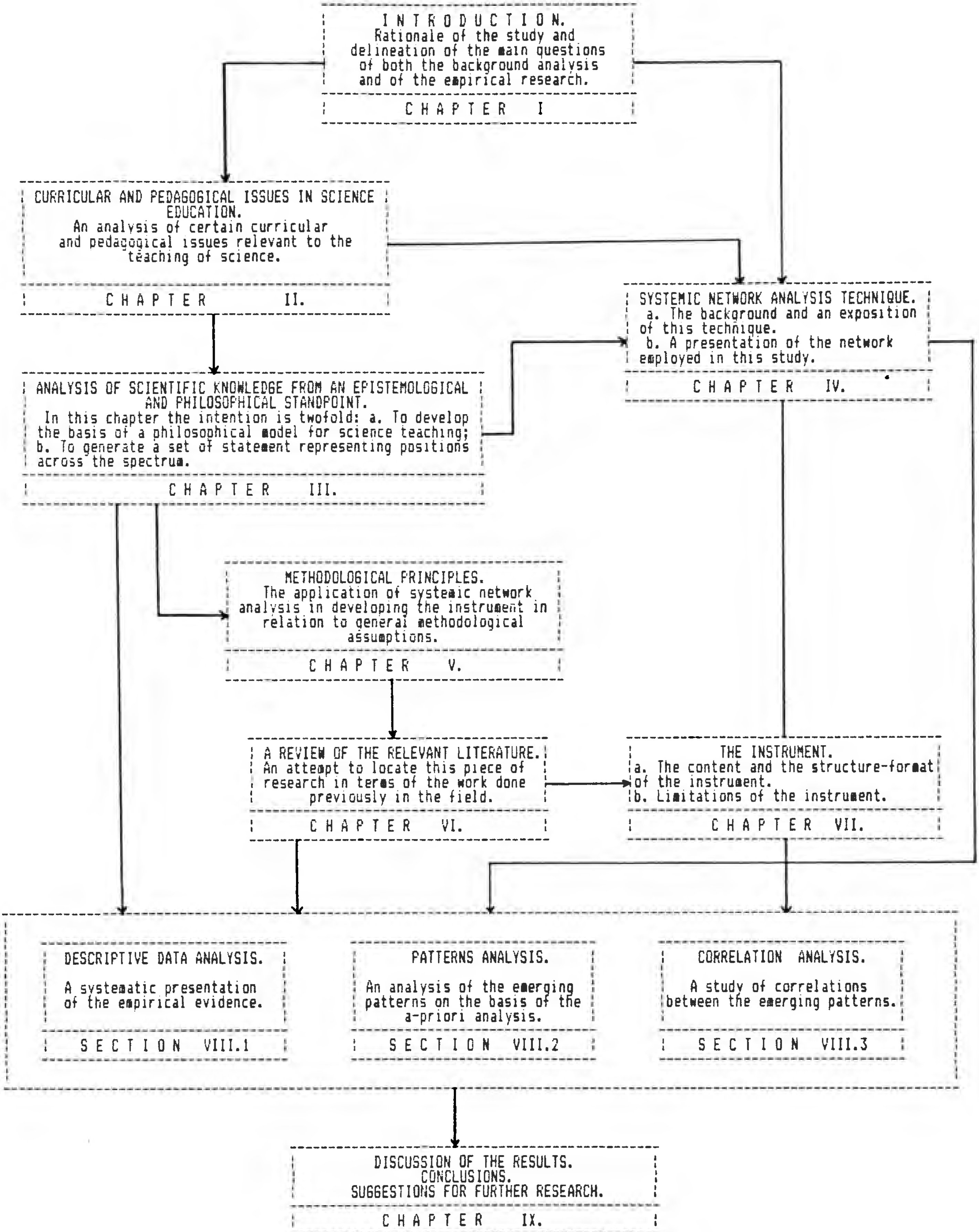


DIAGRAM D1.2: The structure of the thesis.

of a review of the existing studies in the area, with emphasis on their relevance to the empirical element of this research. Finally, the analysis and interpretation of the results and a discussion of the conclusions are dealt with.

Diagram D1.2 presents both the focus of each chapter of the thesis and the way these chapters are articulated. Viewed together they provide an indication of the flow of the overall argument.

In as far as the research instrument is concerned (in accordance with the a-priori analysis on which its construction is based - chapters II and III) consists conceptually of three components (philosophical-epistemological, curricular and pedagogical). Each of these components contains several "themes". In the following table T1.1 the composition of each component is shown, while the full text of the instrument is provided by Appendix 1.

A. Philosophical-epistemological component
   1. Scientific methodology.
   2. Criteria of demarcation.
   3. Pattern(s) of scientific change.
   4. The status of scientific knowledge.
   5. The issue of reality.

B. Curricular component.
   1. The meaning of content and process in science teaching.
   2. The question ofteaching integrated science.

C. Pedagogical component.
   1. Assumptions about learning.
   2. Assumptions about instruction.
   3. Assumptions about classroom activities.

TABLE T1.1: The composition of the components.

Finally, with regard to the empirical element, the instrument has been administered to 54 practising teachers and 41 student teachers (PGCE students). The analysis of the responses aims at discerning both teachers' views on each of the above themes as well as relationships between their views on different themes.

BIBLIOGRAPHICAL NOTES.

[1]. Robinson, J. T. (1969a), p. 100.

[2]. Scheffler, I. (1973) pp. 216-217.

[3]. Robinson, J. T. (1969b), pp. 459-471

[4]. Smolicz, J. J. and Nunan, E. E. (1975), p. 101

[6]. Pine, G. J. and Boy A. (1975), p. 123.

[7] Havelock, R. G. (1973).

[8]. Stenhouse, L. (1975).

[9]. Hart, K., Booth, L., and Turner, A. D. (1982).

[10]. Selkirk, K. (1982).

II. CURRICULAR AND PEDAGOGICAL ISSUES: A brief overview of certain features of the educational landscape.

As far as the curricular and pedagogical issues are concerned, there are a considerable number of issues which one could look at in a multiplicity of ways.

The foci of this chapter are restricted to certain aspects of the debates concerning the curriculum for sciences (the question of "integrated science" and the relevant one concerning how the terms content and process are conceived) and pedagogy (assumptions about learning, instruction, classroom activities). The intention is not to contribute to these debates, but is rather to organise the discussion on the basis of certain distinctions making explicit their philosophical-epistemological concequences. The subsequent construction of the systemic networks for these areas will be based on these distinctions.

Therefore the relation between the systemic networks (which serve as basis for the construction of the research instrument - chapter IV) and the theoretical analysis is here less prominent than the corresponding relation in the philosophical component (chapter III) in two senses:

-firstly, the basic distinctions here are only a small selection of the possible ones (the philosophical component is more complete).

-secondly, these distinctions are not frame in terms of different coherent theoretical systems - rather they reflect them in a more personal way.

However, the theoretical arguments give these distinctions some general support, at least as far as their relevance is concerned.

II.1 CURRICULAR ISSUES: The question of science integration.

With regard to the question of integration one can distinguish between integration across the curriculum (i.e. "integrated" type curricula in Bernstein's terminology [1]) and integration within science (for instance the Scottish integrated science course [2]). The first position entails a radical re-orientation of the traditionally taught science curricula, having been thus the focus of the curricular debates in periods of intense innovation. As it is evidenced however by Brown [3], in terms of justificatory arguments, the latter form of integration is a reflection of the former (integration across the curriculum).

It may seem that generally speaking, there are three perspectives which inform the relevant arguments:

-the first looks at the question from a philosophical standpoint (i.e. forms of knowledge);

-for the second sociological considerations are of crucial importance (e.g. frame of hierarchies).

-practical considerations.

Interestingly, as Brown suggests [4] the first and second of the above perspectives are often treated as antithetical.

In terms of the first perspective, one could discern two main camps. On the one hand, it is Hirst [5] who argue that "all knowledge is differentiated into a limited number of logically distinct forms or disciplines". Furthermore, "these logical forms are characterised by both concepts of distinct type and distinct procedures, which they use to underpin their knowledge claims" [6]. Following a similar line Phenix considers that education is the process of "engendering essential meanings" [7]. Thus, according to this view, a mapping of realms (and sub-realms) of meanings is an indispensable element of any attempt to develop curricula. Furthermore "each realm of meaning and its constituent subrealms may be described by reference to its typical methods, leading ideas and characteristic structures. These features may be exhibited both in their uniqueness for each realm or subrealm and in their relationships and continuities with the other types of meaning" [8].

Clearly then, the logic of the arguments put forward by Hirst and Phenix implies that there are compelling reasons, i.e. different conceptual frameworks and procedures (methodology) which call for the teaching of specialised subjects. It should be noted that according to these views the specialised subjects do not neccessarily have to be the traditionally taught disciplines (e.g. Physics, Chemistry, Biology). For instance Hirst [9] is attacking rather than defending traditional school subjects. Phenix [10] however says "that the curriculum should consist entirely of knowledge which comes from the disciplines, for the reason that the disciplines reveal knowledge in its teachable forms".

In contrast, Schwab [11] argues that scientific knowledge is fundamentally of a revisionary character such that the conceptual framework of science is constantly altered. Furthermore, this conceptual framework (in his terminology "substantive structure of the discipline") is not inherent in the subject matter, but it is imposed by the practitioners.

The implications of Schwab's thesis can be construed in two distinct ways.

a. It could be argued that despite the fact that differences in the substantive structure of a scientific discipline are not built into the various subjects, nevertheless the practitioners consensus to impose such boundaries is beneficial to the process of initiating novices into the respective areas. Then, it follows that the scientific curriculum should be organised in the basis of specialised subjects.

b. From different epistemological and ideological premises one can argue that these externally imposed boundaries are detrimental to the educational processes and therefore the teaching of integrated science should be preferred.

A version of the Kuhnian system serves as the epistemological basis of the first interpretation (see section III.4), while for the justification of the second interpretation one should introduce the sociological perspective. Bernstein [12] introduced the notions of frame and classification as an analytical tool. In this context the curriculum is conceived as a socially determined structure rather than as only the result of an epistemic analysis.

This conception of the curriculum is very helpful and the role of social forces cannot be disputed. The issue however here roughly speaking, is to what extent one can stretch the argument so far as to assert that all forms of knowledge are socially constructed, and are therefore a mere convention. If one accepts this premise, then what follows is that since all knowledge is socially constructed different social groups (e.g. social classes) possess and appreciate different sorts of knowledge (M. Young, [13]). Subsequently Young, using Berger and Luckmann's [14] notion of reality as a social construction maintains that these different sorts of knowledge correspond to different views of reality.

Thus, according to Young's position, social criteria should be employed for the selection and organisation of knowledge which will be offered in schools, if one wants to avoid the imposition of irrelevant knowledge to pupils of disadvantaged social groups.

The counterpart of this position at the epistemological level is relativism: the criteria of what counts as knowledge have only a social (or historical) dimension which changes as society changes. It may be further noted that Berger and Luckmann [15] on whose work this argument draws, distinguish (qualifying their theory) between society as objective reality and society as subjective reality, the latter referring exclusively to "ideology". Thus, if one wants to argue as M. Young without retaining the above distinction one has to argue not only for relativism in epistemological level but also for one or another form of idealism at the ontological level (see section III.6).

One should not however treat Bernstein's and Young's positions as identical. It is true that both start from similar concerns i.e. power distribution within schools and educational equality. It is also true that they both consider integration across the curriculum and within science instrumental for such purposes. The philosophical underpinning of their positions is what makes them fundamentally different.

Bernstein suggests that the introduction of an integrated curriculum is a means serving to disturb the traditional authority structure [16]. In a specialised subject curriculum the established hierarchy of power is isolated into the individual science departments. The integrated curriculum Bernstein suggests is to undermine this structure. This will initiate new relationships not only between teachers but also between staff-pupils and pupils themselves. The situation then in which "less able pupils" do not perform (or even do not have access) to high status subjects will change and all pupils will have a common work task. The implementation of such an educational policy will eventually result in a less rigid structure, which makes the integrated code potentially a code which does not obstruct attempts to reform education. However, this should seen this in the light of Bernstein assertion that education cannot compensate for society [17]. His point is that the ability of certain individuals, groups, classes to impose their "definitions" is based on power inequalities and should be seen in terms of social structures than merely the way in which we perceive social relations [18]. It is clear therefore that no connection with idealism can be possibly established.

Adversaries of the introduction of an integrated curriculum took the opportinity to argue that such a curriculum will bring about deterioration of academic standards. It should be noted however, that empirical evidence (but by no means conclusive) seem to suggest that insofar as the science course is designed for mixed ability classes following a common curriculum, no evidence of lower academic standards has been found (Welch, [19]).

Finally, the question of integration can be seen in terms of practical constraints (e.g. resources, availability of teachers, apparatus etc.). At this level "an integrated scheme demanding a maximum allocation of one fifth of the timetable would do much to overcome those practical problems" (Schools' council, [20]). Furthermore, at a superficial, at least, level integrated curricula can provide a way of avoiding unneccessary dublication of teaching that is common to the various disciplines (Whitfield, [21]).

Summarising the above discussion, table T2.1 below indicate the points on which arguments either for specialisation or integration are based.

Arguments for teaching science in schools in the form of separate subjects can be based on:

1. differences in content between subjects;
2. differences in processes used by subjects;
3. reasons of practical convenience.
4. the need to maintain high academic standards;

Arguments for teaching science in schools in the form of an integrated subjects can be based on:

1. science basic unity of concepts;
2. science basic unity of methods;
3. reasons of practical convenience;
4. the need to make school science relevant to the pupils.

TABLE T2.1: Arguments for specialised subjects and for integrated science.

In the following table T2.2 possible alternatives of meanings attached to the terms content and process in science are suggested (see also chapter III).

The meaning of content in science education could be either of:

a. scientific theories and laws;
b. experimental and/or observational data;
c. techniqes of experimentation.

The meaning of process in science education could be either of:

a. scientific methods (how to be scientific).
b. how to handle experimental or observational data.
c. how to devise experiments.

TABLE T2.2: Meaning of content and process in science education.

BIBLIOGRAPHICAL NOTES.

[1]. Bernstein, B. (1971), pp. 47-69.

[2]. Scottish Education Department, (1969).

[3]. Brown, S. A. (1977), pp. 31-32.

[4]. Ibid., pp. 48-50.

[5]. Hirst, P. H. (1974).

[6]. Hirst, P. H. and Peters R.S. (1970), p. 62.

[7]. Phenix, P. H. (1964), ch. 1.

[8]. Ibid.

[9]. Hirst, P. H. (1974).

[10]. Phenix, P.H. (1962), p. 133.

[11]. Schwab J. J. (1964), p. 203.

[12]. Bernstein, B. (1971).

[13]. Young, M. F. D. (1973).

[14]. Berger, P, L. and Luckmann, T. (1967).

[15]. Ibid.

[16]. Bernstein, B. (1971).

[17] Bernstein, B. (1970).

[18]. Cohen, L. and Manion, L. (1985), p. 38.

[19]. Welch, W. W. (1975) p. 378.

[20]. Schools' Council, (1973), p. 1.

[21]. Whitfield, R. C. (1971), p. 227.

II.2 Pedagogical assumptions: Learning, instruction, classroom activities.

The number of possible pedagogical questions is very extensive. Here, the interest to limited in three areas: assumptions on learning, assumptions on instruction and certain aspects of classroom activities.

Even the use of terms like learning, instruction or practical activities needs further clarification. Thus, by assumptions on learning, in this thesis, the aim, the prerequisite in order for effective learning to take place as well as a way of checking the extent to which successful learning has been achieved is discussed. What is meant by the term instruction are the assumptions about the way teachers organise their lessons (objectives model vs. more interventionist practice), the way knowledge is presented to the pupils (small steps or the whole idea in the beginning), what aspects of motivation are considered to be crucial (e.g. emotional involvement, role of feedback or the active participation of students) and finally how the role of reinforcement is conceived in this frame. Finally, as far as the classroom activities are concerned, some of the elements in terms of control of knowledge transactions as well as what are thought to be the traits of a "successful" teacher are discussed.

II.2.1 Assumptions about Learning.

Theories of learning constitute the most structured theme of the pedagogical component. In this discussion it will be attempted to relate the above mentioned three questions concerning learning to behaviourism, "cognitivism" (Piagetian school or "interactionism") and constructivism. The choice of these systems is due not only to the fact that they are well established within psychology of learning (and therefore more probable to have influenced teachers' thinking) but also because being general permits one to trace their philosophical leanings. It should be noted however that since as stated already the object of this chapter is not a full representation of these systems, the labelling is simply conventional and should not taken be literally.

The main conceptual characteristic of behaviourism, is the argument concerning the "eliminability of mental terms" (and their reference, of course) "from causal accounts" [1]. It should be stressed however, that strictly speaking, behaviourism is not one doctrine. There are said to be at least three significantly different versions:

1. Logical behaviourism,
2. Methodological behaviourism,
3. Radical behaviourism [2].

Their differences lie not in that they differ fundamentally with regard to the above mentioned central tenet of behaviourism, but it is rather a matter of different emphasis. Thus, logical behaviourism maintains that "all mental predicates can be translated, analysed or replaced by behavioural and environmental terms, without any loss to designate whatever is psychologically real" [3]. Indeed Skinner affirms that he is "a radical behaviourist simply in the sense that I find no place in the formulation of psychological explanations for anything which is mental" [4].

Methodological behaviourism is a theory about the methodological constraints properly imposed on the explanatory powers of empirical psychology. In so far as the methodology is concerned, Skinner insists that behaviourism needs not and does not ignore the mental [5]. Radical behaviourism which perhaps is the one stream which draws more upon philosophy, argues that "explanation in terms of cognitive variables are entirely vacuous and mental phenomena are fictions" [6]. If one follows behaviourists who oppose the explanatory use of mental phenomena just because they cannot be observed, then the link of this stream (radical behaviourism) with logical positivism can be easily established.

Clearly therefore, for behaviourists the aim of learning should be the acquisition of knowledge in the sense of the recipient being able to demonstrate a change in behavioural terms by showing the relevant skills (not necessarily practical). On this basis, one has to infer that the assessment of learning outcome should be judged on this basis. As far as the prerequisite for successful learning is concerned, taking into account behaviourists insistence that "each step in the learning process should be short and should grow out of previously learnt behaviour" [7] their stress on the role of the immediate prior knowledge (knowledge in this case should be construed in the behaviourists' sense, i.e. change of behaviour) can be established.

The other two systems, i.e. cognitivism and contructivism differ from behaviourism in that they emphasise the "causal efficacy of internal mental states" [8]. There are however differences between these systems, taken to be represented by Piaget and Kelly respectively. As Bliss argues, whereas Piaget focuses on the mechanism of acquisition of knowledge common to all individuals, Kelly looks at knowledge construction at a level that would generate different results from person to person [9]. Furthermore, Kelly [10] stresses the conscious self-regulation by the individual during the process of knowledge construction, while Piaget thinks the very opposite. Piaget states: "in any case the 'lived' (or conscious) can only have a very minor role in the construction of cognitive structures ... Not until he becomes old enough to reflect on his own habits and patterns of thought and actions does the subject become aware of structure as such" [11].

This difference in emphasis between the Piagetian and constructivist traditions is made clearer when considering how the epistemic subject is conceived within them. Piaget summarising his epistemological views notes: "that [system] draws attention to the activity of the subject without being idealist; that equally bases itself on the object, which it considers as a limit (therefore existing independently of us but never completely reached); and that above all sees knowledge as a continuous construction" [12].

Conversely Kelly, as Fransella and Bannister argue, accepts that "the model underlying construct psychology is explicitly the idea of 'every man his own scientist'". Thus, this theory holds that to study a person is to study the "grammar" of his unique "rationality" [13]. It seems therefore that one can infer that constructivists stress the self perception of needs as a prerequisite of learning and consequently that the individual learner should be judged according to what he/she perceives to be the outcome of the learning process.

Insights regarding the epistemological associations of constructivism can be acquired by taking into account not only the theoretical premises of Kelly but also at looking in the way his work is reflected by a recently growing body of research within science education e.g. Driver and Erickson [14], Pope and Gilbert [15]. A combination of relativism in so far as the status of scientific knowledge is concerned, with methodological inductivism, which is not inconsistent with idealistic ontological tendencies seems to be the features of the relevant works.

Inferences about the pedagogical implications are more difficult in the case of "cognitivism". Piaget's interest was the relationship between epistemology and the psychological formation of ideas and for this reason "almost all [of] Piaget's investigation stem from some philosophical issue about the structure of knowledge and not, as is commonly believed, from a psychological concern about children" (Bliss, [16]). Thus, as Bliss argues, to translate Piaget's work into educational applications one has to move from the level of analysing the epistemic subject to the level of focusing at the child [17].

Such a transition is not facilitated by the fact that arguments put forward by "cognitivism" are not only much more sophisticated and diversified but also because Piaget's work is interpreted very often as "nothing more than a stage naming exercise illustrated by a few rather simplified examples" [18].

It seems that if ones takes into account Piaget's distinction between physical and logico-mathematical activity, crucial for the latter is the ability of the individual to think in abstract terms. Furth writes "Piaget also uses the term 'reflecting' abstraction (for logico-mathematical [activities]) since he considers this abstraction in a manner of an internal feedback. ... The abstraction, as feedback, is an internal regulation mechanism; and as an internal enrichment, it becomes the principal source of growth of the operative structure. This growth takes the form of an internal increase where on a higher plane later structures subsumes or 'reflect' earlier structures" [19].

If then one accepts the main distinctions, the features of each system in terms of aims, prerequisite and assessment of learning can be summarised as follows:

A. "Behaviourism".

1. The basic goal or aim of teaching should be that pupils acquire the knowledge and skills of the subject.
2. To know whether pupils have learned or not, it is important to find out whether they themselves consider that they have learned or not.
3. It is essential to effective learning that account has been taken of pupils' ability to think at a sufficient level of abstraction.

B. "Cognitivism".

1. The basic goal or aim of teaching should be that pupils develop a rational understanding of the subject.
2. To know whether pupils have learned or not, it is important to check what they can or cannot be seen to do.
3. It is essential to effective learning that account has been taken of pupils' perception of their own needs.

C. "Constructivism".

1. The basic goal or aim of teaching should be that pupils form their own individual view of the subject.
2. To know whether pupils have learned or not, it is important to discover whether they have the expected concepts or not.
3. It is essential to effective learning that account has been taken of pupils' immediate prior knowledge.

II.2.2 Assumptions about Instruction.

According to Bruner, assumptions about instruction, could be seen as a "theory", in the sense of setting the rules "concerning the most effective way of achieving knowledge or skills" [20]. Accepting this, one has also to accept its normative-prescriptive character. In this view, this is an important element which differentiates this set of assumptions from what is usually termed theories of learning and development, the latter being descriptive or explanatory rather than prescriptive.

The implication of such a position is that a "theory" of instruction concerned with "how what one wishes to teach can best be learned" [21], by being more practice-oriented, is of more immediate relevance to classroom teachers.

Taking into account these two characteristics of theories of instruction a further distinction can be drawn. It could be argued that the various elements constituting a theory of instruction should be seen as more autonomous and that one can discuss them per se and in connection with the classroom practice rather than seeking to establish complex ramification, as it is the case, for instance, for the epistemological questions. Clearly, this is not to say that the question of internal consistency of a theory of instruction is irrelevant or that it must not be "congruent with those theories of learning and development to which it subscribes" [22].

Bruner further asserts that a theory of instruction should have four main dimensions. In short these dimensions concern:
(a) predispositions, (b) the way knowledge to be presented to the learner is structured, as well as (c) the sequence of the knowledge, and finally, (d) the "pacing of rewards and punishments in the process of learning and teaching" (reinforcement) [23].

A somewhat similar, although much narrower set is employed here, the elements of which roughly correspond to Bruner's dimensions, namely: (a) motivation, (b) general orientation of lessons, (c) pacing of knowledge and (d) the role of reinforcement.

With regard to the first element three not mutually exclusive stances can be established:

-Firstly, the theories of motivation for which active participation is the key element. This idea of the child as an active agent is prominent in both the Piagetian tradition and constructivism (e.g. Kelly) [24].

-Secondly those theories which support that motivation is enhanced whenever an emotional involvement on the part of pupils is achieved (e.g. affiliation, like the teacher and desire for approval) [25].

-Finaly, the behaviourist stream of theories according to which instrumental to motivation is the obtaining of information about how successfully one is performing (feedback). Furthermore, the motivational effects very much depend on the length of the time spent to notify the outcome of the assessment to the pupil. The longer the time the less probable a favourable impact is attained [26].

In so far as the general orientation of lessons is concerned the main distinction is between those who espouse a strictly "objectives" oriented conduct of lessons and others who believe in a more flexible approach, which gives the teacher the ability to respond or intervene according to the needs of the moment. Very briefly, the supporters of the former model argue that it provides a focus for the diverse teaching activities [27], in addition to being essential for purposes of evaluation and assessment [28]. Opponents of this approach counter-argue that by filtering school knowledge through an analysis of objectives, it is bound to end up in defining unacceptable solution - particularly if "knowledge" is treated as problematic rather than given [29].

The pacing of knowledge is the third element to be considered. Skinner suggests a linear teaching programme of which the knowledge steps should be short so as to result a slow build-up in the level of difficulty [30]. Gestalt psychologists on the other hand advocate the presentation of large chunks of knowledge (the whole idea before the elaboration of the details). The justification of such an approach is based on the argument that if one takes parts of the content to be taught out of context, this may lead in rendering the material meaningless [31].

The notion of reinforcement is central to theories in the behaviourist tradition. In its simplest form reinforcement is conceived as positive (reward or praise) and negative (blame). According to these theories, if pupils' efforts are rewarded (or punished) with something they like (or do not like) to receive (establishment of the stimulus-response link), this is more likely to generate in them an intentional behavioural pattern [32]. Therefore, a schedule of reinforcement is indispensable, in this view, for successful learning to take place. Other theories criticise this emphasis on the stimulus-response link because this link which assigns to reinforcement a central place, cannot but eventually lead to uniformity and trivilisation of teaching [33].

II.2.3 Assumptions about classroom activities.

What the term classroom activities is taken to mean here, are those elements of the classroom interaction system which are instrumental to the transmission-interpretation of knowledge. The distinction proposed by Barnes [34] for this purpose, is the basis for developing this theme. According to this distinction one can discern two extreme types of teacher: the "transmission" and the "interpretation" teacher. The transmission teacher "believes knowledge to exist in the form of public disciplines", values the performance of pupils in terms of the criteria laid down within the discipline, perceives "teachers' task to be the evaluation of learners' performance" and perceives the "learner as an uninformed acolyte for whom access to knowledge will be difficult" [35]. On the other hand the interpretation teacher believes "knowledge to exist in knower's ability to organize thought and action", considers both teacher and learner to be the source of the criteria of performance, stresses teacher's task to set up a dialogue through which the learner can reshape his knowledge, and finally perceives the "learner as already possessing systematic and relevant knowledge" [36].

Barnes' intention was to put forward a hypothesis for the construction of a communication model encompassing a whole range of aspects of classroom interaction. Here, the target is narrower and given that some of the elements of this system (e.g. an epistemic analysis of scientific knowledge, certain aspects of science curriculum, etc.) are discussed elsewhere, this framework is modified. For this reason two additional elements are introduced concerning the transmissive-interpretative function of the teacher, so as to demarcate clearly the questions under consideration: the questions are seen in the light of teachers' functions with regard to the control of knowledge transactions in classrooms and complementarily teachers' own perception of the characteristics underlying their roles in the classroom.

Thus, if teachers believe that crucial to classroom activities are clear explanations to which pupils should carefully attend, instead of pupils' investigating problems of their own choice, or if teachers emphasise a reconstruction of scientific knowledge within a carefully guided path, then the teachers lean towards the transmission model, in terms of the first of the above mentioned elements. Of course, if teachers think the pupils' investigations and active discussions to be of primary importance, then one has indications that elements of the "interpretative" model in Barnes' terminology are present. These two approaches concerning teachers' activities in relation to the way knowledge is conceived can also be seen (apart from their transmissional or interpretative function) along the distinction between teacher or pupil-centred orientation respectively.

With regard to the characteristics of a successful teacher as conceived by teachers themselves, the last distinction can be usefully employed. Thus, one can argue that the important elements are teachers' mastery of subject or the extent to which effective teaching techniques are applied (the interpretation of the term teaching techniques be open). Alternatively, the emphasis can be placed on the ability of the teacher to understand pupils' thinking well and his/her commitment to respect pupils' own decisions about their learning.

To conclude, it can be proposed tentatively that the pupil-centred approaches fit better with a "constructivist" theory about learning, while for one to establish possible associations between the approaches which stress other aspects (e.g. teachers' ability for clear explanation etc.), further information about the way instruction is conceived (e.g. pacing of knowledge, how reinforcement is conceived etc. - section II.2.2) is needed.

If this hypothesis is reasonable then one can further suggest a link among philosophical assumptions, assumptions about classroom activities and instruction, through the already argued philosophical implications of the assumptions about learning.

BIBLIOGRAPHICAL NOTES.

[1]. Margolis, J. (1984), p. 36.

[2]. Lacey, H. (1978) in "Theory and Decision", 10, cited in ibid, p. 36.

[3]. Margolis, J. (1984), p. 36.

[4]. Wann, T. W. (ed.) (1964), cited in ibid, p. 37.

[5]. Margolis, J. (1984), p. 37.

[6]. Skinner, , B. F. (1953), cited in ibid.

[7]. Child, D. (1981), p. 89.

[8]. Margolis, J. (1984), chapter five.

[9]. Bliss, J., unpublished paper.

[10]. Ibid.

[11]. Piaget, J. (1968), transl (1971).

[12]. Ibid.

[13]. Fransella, F. and Bannister, D. (1977), p. 4.

[14]. Driver, R. and Erickson, G. (1983).

[15]. Pope, M. and Gilbert, J. (1983).

[16]. Bliss, J., unpublished paper.

[17]. Ibid.

[18]. Ibid.

[19]. Furth, H. G. (1969), cited in J. Bliss

[20]. Bruner, J. S. (1966), p. 40.

[21]. Ibid.

[22]. Ibid.

[23]. Ibid., pp. 40-42.

[24]. Bliss, J., unpublished paper.

[25]. Child, D. (1981), pp. 45-47.

[26]. Ibid.

[27]. Taba, H. (1962); Bloom, B. S. (1970), pp. 25-50

[28]. Popham, W. J. (1969), pp.32-52.

[29]. Young, M. F. D. (1973), pp. 1-17.

[30]. Skinner, B. F. (1953), cited in Child, D. (1981).

[31]. Child, D. (1981), p. 96.

[32]. Skinner, B. F. (1953).

[33]. Stenhouse, L. (1975), ch. 5.

[34]. Barnes, D. (1976), pp. 142-145.

[35]. Ibid., pp. 144-145

[36]. Ibid.

III. A PHILOSOPHICAL ANALYSIS OF SCIENTIFIC KNOWLEDGE.

III.1 INTRODUCTION.

This part of the thesis analyses a number of different epistemological and philosophical positions. The immediate intended outcome is to generate from this analysis, sets of statements, which can be considered to encapsulate each of the philosophical positions under discussion.

Underlying this purpose is that of arriving at a rationale for the structure of an instrument intended to discriminate between different philosophical stances of some complexity. Thus, although the analysis does not pretend to be a contribution to the philosophy of science, it is hoped that it may contribute to clarifying the nature of questions about the philosophy of science as it applies to science education.

For the present purpose, then, the philosophical systems under consideration are distinguished into three levels:

-level III: broad systems of thought in philosophy of science (epistemology) namely, inductivism, hypothetico-deductivism, contextualism (two versions) and relativism.

-level II: philosophical positions having special relevance to philosophy of science i.e. scientific realism, pragmatism (including instrumentalism) and logical positivism.

-level I: general philosophical systems, underpinning any other philosophical (and epistemological) stance, which include realism, scepticism, idealism (as well as some of its versions - e.g. solipsism, phenomenalism).

The discussion is initially organised at level III and focuses on the following themes:

a. scientific method,

b. criteria of demarcation,

c. pattern of scientific growth,

d. status of scientific knowledge,

as they are underpinned by the distinction (or, its absence) between theory and observation. It is however, not enough to treat each independently, since each shares certain features with others, any one position being a configuration of stances concerning deeper or wider issues. For this reason, at the end of the chapter the analysis is developed at levels II and I, attempting to synthesise the previous discussion. At these levels, the issue which is discussed is mainly how reality is conceived within the various systems.

As to why the distinction of the systems under discussion into three levels is considered relevant, one can argue that strictly speaking epistemology as the branch of philosophy concerned with the theory of knowledge. As Harre [1] put it, in epistemological investigations one reflects "on the standards to which genuine knowledge should conform". And it is accepted across the spectrum that the principle of internal consistency is fundamental to such investigations [2]. However, epistemological considerations are based and depend on one's ontological beliefs. Therefore, one can in principle draw a line between epistemological issues (level III) on the one hand and basic philosohical problems (level I) on the other. That is, the "logic" for their demarcation is that antitheses can be solved concerning problems on lenel III by revealing inconsistencies; on the other hand the fundamental questions on level I (and partly on level II) are more a matter of cosmological beliefs rather than points related to consistency.

This programme may seem an impossible combination. This is why the following qualifications should be taken into account:

1. This thesis is not dealing with the philosophy or practice of science, per se. The focus is, obviously, on the teaching of science. Therefore, what is argued should be seen in this light, that is from a pedagogical perspective.

2. The view taken is not that ontological considerations are conditions necessary for the construction of a satisfactory analytical tool for studying science education, given the notorious difficulties which such considerations involve. They are, however, almost

indispensable when one wants to put the discussion in a wider (beyond the "technical") context for purposes of interpretation and conceptual communication between different epistemological positions or even pedagogic stances. Thus one's own position related to, say, the status of scientific knowledge could be contrasted with the consequences of one's fundamental beliefs concerning the existence of theoretical and observational entities, on which any claim referring to the former is founded.

BIBLIOGRAPHICAL NOTES.

[1]. Harre, R. (1972), p. 5.

[2]. Newton-Smith, W. H. (1981) p. 229 and elsewhere;
Feyerabend P. (1978), pp. 210-211, where he rejects the notion that inconsistent scientific theories hinder progress in science but he accepts the need for internal consistency in philosophical arguments.

III.2 INDUCTIVISM: A traditional position.

Dealing for the purposes of this thesis, with a philosophical position like inductivism, the intention is to identify and critically discuss its main general characteristics.

The difficulty of encompassing the subtleties and the details of individual philosophers' arguments in one frame so as to convey the general features of a certain philosophical system (e.g. inductivism) to which they belong, has been already stated. A degree of simplification is therefore inevitable. This general problem is even more acute in the case of inductivism. The reason for this lies simply in the sheer number of great names associated usually with this school of thought - names like those of Bacon, Lock, Mill [1] to mention but a few, referring exclusively to the English tradition.

Thus, trying to give a working account, the discussion will be organized along the following themes:

-the basic tenets of inductivism as emerging mainly from current debates,

-empiricism; the philosophical system which could be seen as akin to inductivism,

-a critique of the arguments which sustain the basic tenets of inductivism,

-discussion of what the basic tenets of inductivism entail regarding other issues of interest within the philosophy of science, namely criteria of demarcation, patterns of scientific growth, status of scientific knowledge and finally, the existence of theoretical and observational entities.

III.2.1 The basic tenets.

The first basic tenet refers to inductive reasoning. As Losee [2] states, inductivism is the point of view which stresses the importance of inductive reasoning to science. According to Ayer [3]:
"inductive reasoning is taken to cover all the cases in which we pass from a particular statement of fact, or set of particular statements of fact, to a factual conclusion they do not formally entail."

A statement to the effect that "they do not formally entail", is obviously in accordance with the canons of formal logic. To be fair, one should emphasise that inductive reasoning entails that a large number of observations be made under a wide variety of circumstances, before concluding (generalising). Consider for instance, the logical schema (being trivial for the sake of clarity):

From :Most of the books on science are boring (A).
And :This book is a book on science (B).
Inference :This book is boring (C).

Statement (C) does not necessarily follow from statements (A) and (B). For instance, asserting (A) and (B) as true and (C) as false, does not necessarily involve a contradiction, because this book may turn out to be one of the minority of books on science which are not boring.

It seems helpful to clarify the meaning of the inductive schema in the light of the important distinction made by Herschel [4] between the "context of discovery" and the "context of justification". The "context of discovery" refers to the inclusion of a "logic of discovery" in the scientific method. According to this view, it is the "logic of discovery", which provides devices to assist the scientists in the discovery of new theories [5].

Losee [6], in presenting Herschel's notion of the "context of discovery", distinguishes three steps in the process of discovery: The subdivision of complex phenomena into their constituent parts, followed by focusing attention on their properties, which are crucial for the explanation of the phenomena in question, is the first step. The second step is the formulation of "laws of nature" which are based on the

The context of justification as Hacking [9] explains it, "is the questions regarding the soundness of the intellectual end product. Is it reasonable, supported by evidence, confirmed by experiment?"

Looking back to the meaning of the "context of justification" according to Herschel, one can see his emphasis on agreement with observation , as the most important criterion of acceptability of scientific laws and theories [10].

Summarising the above, the inductivist position entails a clear cut distinction between discovery and justification. In the context of the former, scientific enquiry is a matter of generalisation from facts (that is, the results of observation and experiments) [11]. This does not necessarily imply an active interest on the part of inductivists in the context of discovery. On the contrary, many of them (and particularly those who espouse logical positivism - an extreme version of inductivism [12] - whilst holding that the context of discovery is a legitimate object of investigations in other fields, e.g. psychology, or sociology of knowledge), stress that it does not (in both a descriptive and prescriptive sense) fall within the interests of philosophy of science. On the other hand, with regard to the context of justification, this position maintains that a scientific law or theory is sound only if the evidence in its favour conforms to the inductive schema. It should be stressed that one of the important aspects of the inductive schema is the principle of verification ("supported by evidence, confirmed by experiment" [13]).

Another main tenet of inductivism is the dichotomy between facts (observations and experiments) and theory. In a sense, this follows from the very substance of the inductive schema. This is due to the fact that scientific laws or theories are, as already stated, generalisations of facts. It is not therefore unreasonable to argue that this presupposes a distinction between facts and theories. Otherwise, one would not be able to strictly isolate facts, before attempting any generalisation leading to theories.

Stating this view in a more "technical" way, the terms contained in every scientific statement or expression could be either observational (O-terms), or theoretical (T-terms) [14]. Thus, one can speak about the proper analysis of the phenomena, as in the first step. There are two distinct paths leading to the discovery of the "laws of nature", from the phenomena.

The first path is by application of a specific inductive schema. For example from the data:

F	x
1	10
2	20
3	30
4	40

the scientist could conclude that the ratio F/x is constant.

Formulating hypotheses is the second path to the discovery of scientific laws. However, Herschel stressed that this latter path cannot be reduced to the application of fixed rules. Furthermore, the discovery of the "laws of nature" is only the first stage of the scientific enterprise.

Its second stage is the integration of these laws into theories, which constitutes the third and last step of the process of discovery. "This consists of either further inductive generalisation or the creation of bold hypotheses that establish an interrelation of previously unconnected laws" [7].

Herschel's view of the context of discovery may be represented diagrammatically (taken from Losee [8]) as follows:

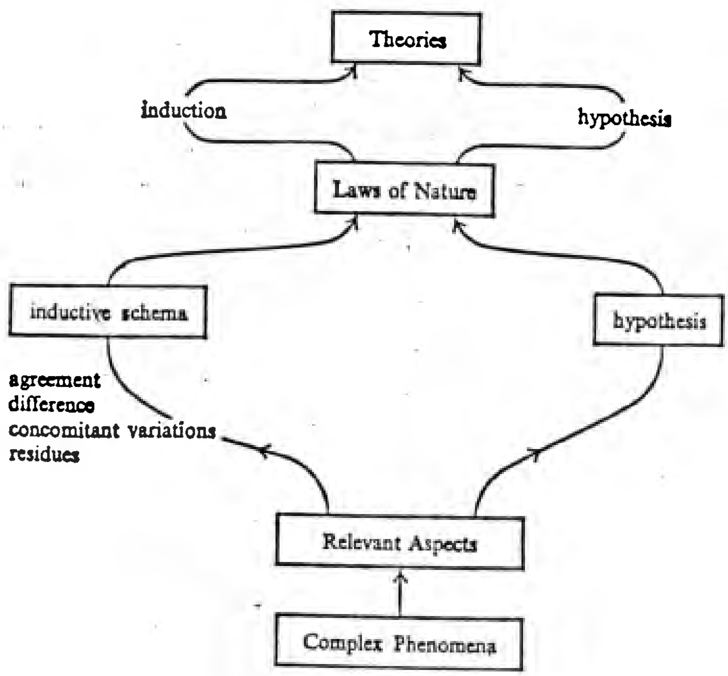


DIAGRAM D3.1: Herchel's pattern of discovery.

distinction between O-terms and T-terms. A concrete example is

the O-term: "... is cold"

as opposed to

the T-term: "... is an electron".

It seems that the three principles of inductivism, to which Harre is referring, transmit the essence of what has been said up to now on inductivism. These principles are as follows:

-The principle of accumulation: "scientific knowledge is a conjunction of well attested facts" and it "grows through the addition of further well attested facts".

-The principle of induction: "there is a form of inference of scientific laws and theories from accumulated simple facts, so that from true statements describing observations and the results of experiments, true scientific laws and theories may be inferred".

-The principle of instance confirmation: one's "belief in the degree of plausibility of a [scientific] law or theory, is proportional to the number of instances that have been observed in the phenomenon described in the law" (or theory) or, that have been observed to verify the law (or theory) [15].

Despite the fact that these three principles are very comprehensible, a significant point, which could be made considering the inductive schema and the distinction between theory and observation, would appear to be missing.

Thus, the inductive schema postulates something more concerning the nature of the difference between theory and observation (or, T-terms and O-terms) beyond ascertaining the very existence of this difference. That is, since the facts form the only secure basis for a scientific theory, they should in some sense occupy a higher status vis-a-vis theories.

Newton-Smith commenting on this, remarks that one can grasp the meaning of "... is cold", on the basis of one's perceptual experience, "with a high degree of justified confidence and without the help of any scientific theory" [16]. By contrast, one does not sense the presence of electrons in the way one senses that something is cold. Besides, to learn what is meant by the term electron, "one has to have at least a partial mastery of a complex scientific theory" [17]. This constitutes an intuitive characterisation of the difference between theory and observation (or, more precisely between T-terms and O-terms), which has a semantic and an epistemological aspect.

Now, if one wants to defend (and inductivists undoubtedly do) the position that the theory/observation distinction represents a difference in kind and not a difference in degree, (observations being privileged), then, one has to defend the view that observations are either semantically privileged, or epistemologically privileged, or both.

What does this mean? It signifies that the propositions one needs to sustain in order to defend the privileged position of observations could be stated as follows:
"if O-terms (observations) are semantically privileged in the sense that their meaning could be conveyed through their connection with experience, it was thought that their meaning would remain constant through theory change" [18] (the semantical aspect of the distinction).
And
"O-terms are not fallible as T-terms and therefore, they do constitute a completely secure basis, on which to build scientific laws and theories" [19] (the epistemological aspect of the distinction) [see note (a) on III.2].

Both statements (particularly the second) are connected with aspects of another distinction (human mental constructs versus the external world), concerning the very nature of observations and their perception, and consequently, the claims for knowledge based on them. This distinction arose from the development of empiricism; for this reason, empiricism will now be discussed historically.

III.2.2 The historical predecessors: Empiricism.

The origins of inductivism can be traced back to Babylonians. Harre, (contrasting Greek and Babylonian astronomy) writes:
"For the Babylonians the tables of ephemerides were constructed by the use of numerical rules derived as inductive laws... In this sort of science we have theory only in the sense of an explanation of the phenomena" [21].

It was however the empiricists, particularly Locke and Hume, who articulated a philosophical position concerning knowledge claims, for which the distinction between the constructs of our mental activities and the external world was essential.

Their positions are of great interest in the context of the philosophical system under discussion, however their treatment will be extremely brief and fragmentary. They are of interest not only because current epistemological debates concerning the observation/theory distinction echo their own aforementioned distinction, but also because central to their arguments, is the issue of whether the entities - which they called the external world - exist independently of human mental constructs, or not. It is the old (from Platonic times) realist-idealist dispute.

Locke [22], who, having defined an "idea" as "whatsoever is the object of understanding when a man thinks", asked how our minds are conquered by ideas which constitute "all the materials of reason or knowledge" and answered that they all come from experience. "In that all our knowledge is founded, and from that it ultimately derives itself" [23]. And what is the source of experience? It is the 'real world', "the world external to our minds consisting of entities which have an existence independent of any mental goings on" [24].

For Locke therefore, it is an epistemological gap which separates the real external world, which exists independently of human thoughts and constitutes the basis for them and the realm of ideas, that establishes our experience. It is what Kant called "transcendental realism" [25].

Hume, in "A treatise of human nature" [26], giving the term "idea" a meaning similar to the contemporary one of concept [27], maintained that all our ideas derive from sense data, which he calls impressions. This is a position similar to that of Locke, in terms of the "ideas - external world entities" distinction.

What must be stressed in considering the empiricists in relation to inductivism, is that they do not necessarily share every feature of it. This is because of what is conceived to be an analogy in their position regarding the significance of the theory-observation and ideas-external world distinctions, respectively, that an association can be established.

In this light, Ogborn's reading of Bacon is most interesting. As he argues, Bacon - an empiricist (empiricism being distinct from inductivism) - wrote explicitly against inductivism: "...induction which proceeds by simple enumeration is childish"; and "...to conclude upon a bare enumeration of particulars (as the logician does) without instance contradictory, is a vicious conclusion..." [28]. A seed of falsificationism [29] is quite obvious. So Ogborn's contention that "Baconian induction is a philosophical myth" [30] seems to be justifiable. Taking this into account, the need for careful analysis and avoidance of indiscriminate use of labels in educational research becomes more apparent [see note (b) on III.2].

III.2.3 A critique : The seductiveness of intuition.

In this section the intention is to critically discuss the two basic tenets of inductivism, namely the contentions that:

-the inductive schema of reasoning should be followed in science;

-there is a sharp distinction between observation (facts) - theory; observations being privileged vis-a-vis theories.

Regarding the first of these points, it is clear that this cannot be justified by appealing to formal logic. On the other hand, since inductivists argue about the future or the unexperienced parts of the past or present on the basis of experience, it is not unreasonable to ask in accordance with their own standpoint, how the principle of induction can be derived from experience.

It was Hume [31], who first posed this problem of induction, that is, whether we are entitled to infer unobserved cases from observed cases, however many. His answer was negative. Any argument purporting to justify induction on the basis of experience, "is circular, because it employs the very kind of inductive argument, the validity of which is supposed to be in need of justification" [32] as the following example shows:

Premise: The principle of induction has worked successfully in many instances.

Conclusion: The principle of induction always works.

Therefore, as Russel put it "we can never use experience to prove the inductive principle without begging the question" [33].

Possible responses to this critique could be either in the form of a retreat to scepticism [see note (c) on III.2], or the total rejection of inductivism as a form of reasoning appropriate for science (e.g. Popper, [35]).

However, a third response seems to be possible in defending inductivism, although this results in the presentation of a weaker version of it, by introducing the notion of probability in some sense.

Let us imagine someone without any knowledge of science. Clearly, such a person expects that the sun will rise tomorrow, or that when throwing something off the roof it will fall. However, as Russell [36] states, if the principles of induction are unsound, he (or she) has no reason to hold that these events are forthcoming or even very probable [see note (d) on III.2]. Obviously, it is rather difficult to deny that arguments like these, however trivial they may appear, have considerable intuitive force. Needless to say inductivism (which otherwise is weak, e.g. from the perspective of formal logic) draws all its strength from these intuitively powerful arguments.

Nevertheless, defending inductivism along these lines (by introducing the notion of probability and appealing to intuition), one has to presuppose the theory-observation distinction, at least in so far as the introduction of probability is concerned.

At this point, Newton-Smith's distinction between the semantic and epistemological aspects of the second main tenet of inductivism (theory-observation dichotomy) is pertinent.

The semantic aspect postulates observation to be completely independent of theoretical assumptions. Opponents of inductivism have argued that there is a fallacy in this claim. For instance, a certain theory on gases is necessarily presupposed to render the statement "oxygen is a gas" meaningful. Thus, as Kuhn [38] notes, until 1756 when J. Black proved that carbon dioxide was a gas different from atmospheric air, samples of gases were thought to be distinct only in terms of their impurities and therefore a statement like the above, did not make sense. Furthermore, it is evident that there are numerous other examples [see note (e) on III.2] supporting the assertion that "clearly formulated theories are a prerequisite for precise observation statements" [39].

At the very least therefore, the inductivists' account of the derivation of universal statements (theories, laws) from singular statements (observation) - i.e. the semantic aspect of the theory-observation distinction - seems to be in doubt.

The epistemological aspect of the theory-observation distinction entails that observations are the only secure basis for establishing scientific theories and laws. Here again, the history of science provides an abundance of instances which go against this claim. For example, Feyerabend [40] refers to an astronomical observation made by Kepler, through a Galilean telescope: "Mars is square and intensely coloured". If one accepts the intellectual honesty of Kepler and, since the falsity of the statement is well established nowadays, one can only accept that observation statements can be false. An explanation of this could be in terms of the predominant theory, which in many cases directs the attention of the observer to specific aspects of the observed. It is obvious that a contention like this is at odds with inductivism. Instances like the above suggest that theory could precede and dominate observation (e.g. Rosen [41], refers to such examples, taken from astronomy).

For the sake of fairness however, it should be added that inductivists have a counter argument. This is based on a modification of the aforementioned distinction between "context of discovery" and "context of justification". Under the pressure of critical arguments, sophisticated inductivists (e.g. Carnap [42], Feigl [43]) have abandoned any claim of jurisdiction over the philosophy of science in the context of discovery, maintaining that only the justification of scientific theories is legitimately within their realm. According to their position, discovery could precede observation (although the question of the origin of theories is not within the scope of philosophy of science). In contrast to discovery, justification, which is a logical (i.e. a-historical, by definition) reconstruction of scientific theories, is immune from arguments based on historical examples. Therefore, these historical arguments do not constitute a compelling logical reason for one to abandon either the clear cut distinction between theory and observation, or even the precedence of observations over theories.

It is arguable that there is no apparent a priori reason for one to concede the legitimacy of the discovery-justification context distinction [44]. However, even conceding this point (i.e. the epistemological aspect of the theory-observation distinction), the argument of observation being theory loaded (semantic aspect) remains unanswered. These two aspects are interrelated. Stretching the anti-inductive argument somehow with regard to the semantic aspect, one ends up within the epistemological aspect. This is because, if observations are theory loaded and theories are fallible, observations are also fallible (at least, to the extent to which they are theory loaded).

In conclusion, it is clear that the basic tenets of inductivism, despite their considerable intuitive force (which is even greater in terms of the inductive schema of reasoning, as opposed to the theory-observation distinction), present many problematic aspects. This agrees with Chalmer's [45] assertion that inductivism cannot throw any new and interesting light on the nature of science, especially as it neglects any interaction of science with the social environment and serves to justify its description as being deadlocked [46]. It should be stressed however, that this is not saying that its intuitive appeal has been definitely refuted.

III.2.4 Some further aspects of an inductive image of science.

Thus far, the inductive schema of reasoning and the distinction between theory and observation as held by inductivists, has been analysed and critically discussed. In the following section, the way in which the other central themes in this thesis (namely, demarcation criteria, patterns of scientific growth, the status of scientific knowledge and problems related to reality) are derived from these basic tenets of inductivism, will be discussed.

With regard to the problem of demarcation, inductivism is very clear: one can distinguish scientific knowledge from non-scientific knowledge (and by the same token choose between competing scientific theories). The criterion for such a distinction is whether or not the inductive schema is being properly applied.

Taking into account the inductivists' tenet that observations are privileged vis-a-vis theories, it follows that their position on science is that it grows through an accumulation of observations and experimental facts. Thus, according to inductivism, relativity for instance, is a generalisation of Newtonian mechanics.

Referring to the status of scientific knowledge, it follows that knowledge produced by an accumulation of observation and experimental facts is objective, since observations are beyond any doubt objective and not related to the subjectivity of the observer.

Finally, there is the problem of reality. No one account will serve to describe the views of all or even of most inductivists. Indeed, some inductivists say that only entities involved in observations exist independently of human thoughts about them. Others could equally defend their positions adopting an idealist stance, saying for instance that neither theoretical nor observational entities exist independently of human thoughts. In this case however, since only observational entities can be sensed, they alone constitute the only secure source of knowledge, being in that sense privileged.

III.2.5 Encapsulating the inductive image of science.

In this section a set of statements is presented, which according to the above analysis will be considered to represent an inductive image of science, in an attempt to produce a reasonably accurate, although simplified depiction. The construction of the part of the research instrument referring to inductivism will be based on these statements.

Similar sections, with the same purpose, and subject to the same qualifications, will be given for each succeeding discussion of the main philosophical positions.

1. For the different kinds of scientific enquiry there is basically one scientific method.

2. The scientific method is to start from data about a problem, basing hypotheses on the data.

3. When the consequences of a theory are compared with data, sound conclusions can be drawn if, and only if, theory and data agree.

4. When there is a debate about whether a given theory is to be regarded as "scientific", there are rational and defensible criteria for making the decision.

5. When there are competing theories and scientists want to decide between them there are rational and defensible ways of doing so.

6. In general the better of two competing theories is the one which is nearer to the "truth".

7. To be sure of approaching nearer to the "truth", one should follow the appropriate scientific method.

8. As science changes or develops, new knowledge generally replaces ignorance or lack of knowledge.

9. New scientific knowledge arises mainly through an accumulation of new experiments and observations.

10. The status of scientific knowledge is different from other kinds of knowledge, having a characteristic value of its own.

11. Scientific knowledge has particular characteristics in that it attempts to be an objective account of Nature.

Notes on III.2

*(a). Another way to put it, could be that observations could apply without making any theoretical assumptions, that is observations are theory-independent [20]. A closer examination of the implications entailed by such a position will be made later.

*(b). This point is further elaborated in the chapter dealing with methodological issues.

*(c). Following this line, an empiricist, who assumes experience as the sole source of knowledge, is bound to be led to scepticism (e.g. Hume), as maintained by Russell [34].

*(d). An interesting, although unconvincing in terms of the perspective of this thesis, counter-argument was put forward by Feyerabend in "Against Method" [37].

*(e). One of them is almost common place (although its interpretation is far from being unique) in the relevant literature: the term "force" as employed in Newtonian Aristotelian, or quantum mechanics not to mention its multifarious and imprecise use in every day language.

BIBLIOGRAPHICAL NOTES.

[1]. Russell, B. (1946).

[2]. Losee, J. (1980), p. 148.

[3]. Ayer, A.J. (1956), p. 72.

[4]. Herschel, J.F.W. (1830), pp. 88-90.

[5]. Newton-Smith, W.H. (1981), p. 1.

[6]. Losee, J. (1980), pp. 115-120.

[7]. Ibid., p. 118.

[8]. Ibid., p. 116.

[9]. Hacking, I. (1983), p. 6.

[10]. Losee, J. (1980), pp. 153-155.

[11]. Ibid., p. 148.

[12]. Chalmers, A.F. (1982), p. 35.

[13]. Hacking, I. (1983), p. 6.

[14]. Newton-Smith, W.H. (1981), p. 19.

[15]. Harre, R. (1972), p. 42.

[16]. Newton-Smith, W.H. (1981), pp. 22-23.

[17]. Ibid., p. 22.

[18]. Ibid., p. 23.

[19]. Ibid., p. 23.

[20]. Chalmers, A.F. (1982), p. 22-23.

[21]. Harre, R. (1972), p. 46.

[22]. Locke, J. ed. by J.Y. Yolton (1961), Book I, Chapter I, Section 8.

[23]. Ayer, A.J. (1976), p. 59.

[24]. Hacking I. (1983), p. 96.

[25]. Ibid., p. 96.

[26]. Hume, D. ed. by L.A. Selby-Bigge (1965).

[27]. Ayer, A.J. (1976), p. 61.

[28]. Bacon, F. (1960), paragraph XCV.

[29]. Hacking I. (1983), p. 247.

[30]. Ogborn, J. (1985).

[31]. Hume D. ed. by L.A. Selby-Bigge, (1927), Section V, Part I, pp. 46-48.

[32]. Chalmers, A.F. (1982), p. 15.

[33]. Russell, B. (1973), p. 38.

[34]. Russell, B. (1946), p. 698.

[35]. Popper, K. (1979), Chapter 1.

[36]. Russell, B. (1973), pp. 33-34.

[37]. Feyerabend, P. (1975), Appendix 4, p. 221.

[38]. Kuhn, T.S. (1970), p. 70.

[39]. Chalmers, A.F. (1982), p. 29.

[40]. Feyerabend, P. (1975), p. 126.

[41]. Rosen, E. (1959).

[42]. Carnap, R. (1962).

[43]. Feigl, H. (1970), p. 4.

[44]. Chalmers, A.F. (1982), p. 35.

[45]. Ibid., p. 36.

[46]. Lakatos, I. (1978b), chapter 8.

III.3 HYPOTHETICO-DEDUCTIVISM: A continental tradition.

It would seem that hypothetico-deductivism could best be conceived as setting out to take the offensive in defending the place of rationality in science. In this programme the target is two-fold: firstly, to criticise the empirico-inductivistic heritage of science, which leads either to scepticism or to idealism; and secondly, to defend realism-based rationality in science against the current relativistic trends, which tend towards agnosticism.

Thus, it would not be inaccurate to describe recent philosophical debates as a three cornered fight between logical positivism (the inevitable extreme form of inductivism), hypothetico-deductivism and relativism. Of added interest, particularly from an educational standpoint, is the introduction of historico-sociological factors and certain psychological considerations within this debate [1].

In the following section, an attempt is made to provide an account of the main features of hypothetico-deductivism and some criticisms of them. It should be stressed that the system to be presented represents by no means a stance taken by one particular philosopher. Nonetheless, in this stream of thought, the sources will be primarily the writings of Popper and Lakatos, who, in the context of this thesis are considered to speak for hypothetico-deductivism.

III.3.1 The main hypothetico-deductivistic theses: A "rational" tableau of science.

One element which characterises this position is that its exponents present a direct and integrated account of their view of the scientific enterprise, as opposed to a debate on particular issues. Thus the hypothetico-deductive tableau consists of points referring to methodological issues such as the permissible form of reasoning in science (deductive structure of theories), the type of evidence to be sought (priority of falsification as opposed to verification), the nature of differences between observational facts and theory (O-terms/T-terms distinction), the pattern of scientific growth, criteria of demarcation, the status of scientific knowledge and the question of reality.

A second major element of hypothetico-deductivism, is its retention [2] of the distinction between discovery and justification, which constitutes a cardinal component of inductivism (and logical positivism) [3]. For this reason, this philosophical system, quite distinct otherwise from logical positivism [4], is equated sometimes with the latter [5]. Of course one could argue that they differ in a number of minor points as there is a great deal of common ground [6] and consequently that they are essentially versions of the same philosophical system. However, in the face of their quite numerous, and in my view significant differences [7], this view is not adopted here.

The Popperian schema of reasoning for science, prescriptive rather than descriptive in character, is intended to be very rational. That is the reason why, as Newton-Smith [8] remarks, Popper has specified both an aim for the scientific activity and certain methodological principles.

Regarding the aim, Popper writes in "Objective Knowledge" [9]: "Our main concern in science and philosophy should be, the search for truth". One can encapsulate the central aspect of Popper's position in so far as the methodological issues are concerned, in two inextricably connected theses:

-firstly, that only deductively valid arguments are admissible in science [10] and

-secondly, through the principle of falsification: i.e. science as a process of falsification by instances of conjectures which are not necessarily entailed by the facts hitherto known. Popper [11] expresses it this way, in his famous dictum: "the method of science is the method of bold conjectures and ingenious and severe attempts to refute them".

The above statements delineate in outline three basic aspects of Popperian philosophy. They need to be elaborated to show how (a) the notion of criteria of demarcation is derived, (b) how the distinction (or its absence) between observational facts and theory is managed and (c) how the pattern of scientific growth is conceived.

Firstly, the notion of truth will be considered. As Popper has stated:

"We should seek to see or discover the most urgent problems and we should try to solve them by proposing true theories....; or at any rate by proposing theories which come a little nearer to the truth than those of our predecessors" [12],

and later,

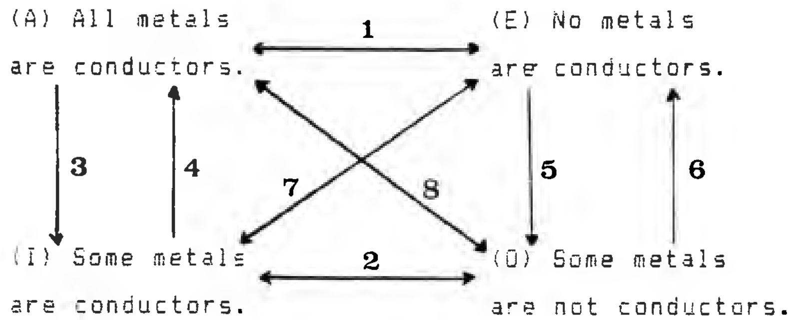
"I accept that truth is correspondence with the facts (or with reality); or more precisely that a theory is true if, and only if, corresponds to the facts" [13],

and finally,

"the idea of truth is absolutist, but no claim can be made for absolute certainty: we are seekers for truth but we are not its possessors" [14].

Newton-Smith [15] is therefore correct to argue that Popper s view of the inaccessibility of truth led him to reconstrue the aim of science as that of achieving a better approximation to the truth, which Popper called achieving a higher verisimilitude, or a higher truth content of certain theories. This position, as Popper [16] explicitly acknowledges, is influenced by Tarski's views in the latter's "Logic, semantics, mathematics" [17].

Turning to the methodological issues, an account of Popper's prescription of the scientific method and its diagrammatic representation taken from Harre [18], will be used. (One should bear in mind that central to this are the above stated contentions that only deductively valid arguments should be used in science, together with the principle of falsification).



The forms of reasoning are indicated by routes 1-8.

-Reasoning along routes 4,6 is inductive in character, inconclusive by nature and therefore should be excluded from science.

-Statements (A) and (E) (route 1) cannot both be simultaneously true.

-Statements (I) and (O) (route 2) cannot be simultaneously false.

-Reasoning along routes 3,5 is deductive in character, but inconclusive as to the truth of the antecedents. Statements (I) and (O) "verify" statements (A) and (E) respectively, but not conclusively.

It is therefore routes 7,8 which are deductive in character and which employ falsification [the truth of (I) contradicts (E) and the truth of (O) contradicts (A)], which provide conclusive arguments and which should be used in scientific reasoning, as Popper has advocated.

The notion of verisimilitude, which is central to both aim and method of science on the one hand, and to the pattern of scientific growth on the other, could be seen as bridging these two aspects of science. As Popper put it, "All growth of knowledge consists in the improvement of existing knowledge which is changed in the hope of approaching nearer to the truth" [19]. This is so (according to this view), because a scientific revolution, however radical, cannot really break with tradition since it must preserve the success of its predecessors. However all knowledge is seen as theory-impregnated, including our observation [20]. It is not unreasonable therefore, to say that this view implies that the growth of science is in fact a succession of theories, each having greater truth content than the one it replaces, without nevertheless being incompatible with each other.

This problem however, is similar to that of the criterion of demarcation. Accepting that science proceeds this way, how can one be sure as to what criteria to use in order to judge the truth-content of a newly proposed theory, which is intended to replace the accepted theory? Furthermore, how can one distinguish between scientific and pseudo-scientific theories?

This question is an intriguing one in the context of Popperian philosophy, given that Popper has asserted (explicitly and implicitly [21]) the possibility of a criterion of truth.

The explicit argument is roughly speaking as follows: scientific theories contain universal propositions over large domains (possibly infinite). However, "in real time we cannot fix the truth value of more than a finite number of basic statements drawn from observation" [22]. Therefore, we cannot derive the truth of generalisations which range over a larger domain - possibly infinite - from such information (this argument could be seen as anti-inductive). The implicit argument is that observational statements are not factual and therefore true by virtue just of being observation (as inductivists and logical positivists argue), since according to Popper all of them are "theory-impregnated". Consequently, there is no more justification for believing an observation statement, than there is for believing the pertinent theoretical sentences, unless observation contradicts its own theoretical premises (falsification). In the latter case the evident power of the observation is obviously much greater (i.e. conclusive in the Popperian sense).

In this philosophical framework the force of the implicit argument depends on the way the distinction between theory and observation is conceived. A brief aside to elaborate this point follows.

For Popper [23] (but not for Lakatos [24]), there exists a distinction between observation and theory. However this distinction does not mean that observational statements are epistemologically privileged vis-a-vis theoretical statements, as the inductivists hold. The opposite is in a sense true for Popper, because for him, even the humblest of observations presupposes (either explicitly, or implicitly) a kind of theoretical assumption [25].

For instance, even for the statement "This is a cube of ice", one has to appeal to parts of theory in order to claim the truth of this statement; in this case the theory referring to the formulation of ice or geometrical considerations about cubes [26]. Besides, it is theory, which as Popper [27] argues, directs attention to what appears to be the relevant aspects of the phenomenon under consideration, while what seems to be irrelevant is ignored. It is in this sense that the proposition "observations are theory-laden", has to be understood.

The above paragraph states what the distinction between theory and observation is not. A positive account, according to the stance in question, distinguishes observational statements from theoretical ones, in terms of their form and their role. Popper's favourite example of an observational statement (basic in his own terminology) is as follows: "there is a raven in spatio-temporal region K". Thus, in terms of form, observational statements are "existential assertions about some definite spatio-temporal region" [28]. In so far as their role is concerned, observational statements are the potential falsifiers of a theory.

Having dealt with the issue of the observation-theory distinction, I shall return to the question concerning the basis for the criteria of demarcation, which remains open. In the context of hypothetico-deductivism, the answer is to be found in methodological terms [29].

An example of a logical schema, which is correct in the Popperian sense, could approximate:

(i). Hypothesis: All ravens are black.

(ii). Observation: A raven, which was not black, was observed at place x at time t.

(iii). Conclusion: Not all ravens are black.

The traits of the above logical schema are two:

-firstly, it is deductive in character,

-secondly, the premise (in a scientific context, a theory, or a hypothesis) can be falsified.

It is upon these characteristics that the criterion of demarcation is based. Theories or hypotheses which do not conform to this schema should not be regarded as scientific. Thus for example the statement: "All points on an Euclidean circle are equidistant from the centre" is not scientific in character according to this view, as it cannot be falsified [30], being instead true by definition. Of course, Popper's main attack is on statements purporting to be scientific, but which in his view are not - those of psychoanalysis, for example.

One could say therefore, that for Popper science is distinguishable from non-science, in that scientific theories ought to have a deductive structure and be potentially falsifiable. What is the position then, regarding the choice between two competing theories which both have the required traits?

It seems that Popper downplays this question [31]. Considering the comparison of rival theories, he focuses on the highly special situation of a pair of theories; let us say theories A and B, A entailing B, but B not entailing A. In the Popperian terminology, theory B is the weaker [32]. The very term indicates the outcome. Indeed: "If we fail to refute it, or if the refutations we find are at the same time also refutations of the weaker theory..... then we have reasons to suspect or to conjucture that the stronger theory has no greater falsity content than its weaker predecessor, and therefore that it has a greater degree of verisimilitude" [33].

Evidently, what differentiates the stronger from the weaker theory is its content. The former is more general (in the sense that it entails, without being entailed) than the latter and that should be the basis for choosing between them.

However, as it has been previously pointed out this is a special case. If a clearer position is wanted, which is still within the general frame of hypothetico-deductivism or modern rationalism, one should consider Lakatos.

With respect to this problem, Lakatos objected to Popper. He argues that Popper tends to represent the scientific exercise as a fight between theory and experiment, seen as two isolated combatants, so that the only conclusive outcome can be the falsification of the theory [34]. However, the history of science suggests that tests are three cornered fights between rival theories and experiments. As a consequence, Lakatos put forward his terms for choosing between two rival theories, for instance T′ (the new) instead of T (the old):

-theory T′ has more empirical content over T;

-theory T′ explains everything that T explains;

-some of the excess content of T′is corroborated [35].

However, as Lakatos has emphasised, this is a general principle, which should not be construed as a binding rule for selecting a research programme, or choosing between them: every decision about the relative merits should be "with hindsight" [36], [37].

This line of thought led Lakatos to modify in addition, the Popperian model of scientific growth. Thus, according to Lakatos, science grows through a succession of better and better theories; but the rejection of theory T on behalf of a new and better theory T′, should not proceed without previously trying to modify T in such a way as to produce a theory better than both T and T′ [38]. Thus, in terms of the Lakatosian model, what transpires is that science proceeds through a sequence of theories, in which each theory is generated through a modification of its predecessor; this sequence is in Lakatosian terminology a scientific research programme.

What remains to be discussed then, is the status of scientific knowledge and the issue of reality, in the context of this system.

With regard to objectivity, a useful distinction can be drawn between weak and strong objectivity [39]. According to this distinction, a statement is weakly objective if it is supposed to be valid for any observer. Weak objectivity in this sense, is synonymous with inter-subjectivity. On the other hand, a statement is strongly objective if it refrains from making any reference to any community of human beings. Positively speaking, the objectivist in the strong sense, gives priority in his analysis of knowledge to the traits of bodies of knowledge which are independent of the subjective states of individuals (attitudes, beliefs, etc.) who may consider such bodies of knowledge.

As a matter of fact, Popper draws a distinction between knowledge in the subjective sense and objective knowledge, defining the latter as follows: "knowledge in the objective sense is totally independent of anybody's claim to know, it is also independent of anybody's belief, or disposition to assent; or to assert, or to act... it is knowledge without a knower: it is knowledge without a knowing subject" [40].

At a later stage, in his first thesis concerning the status of scientific knowledge, Popper [41] states that knowledge in the subjective sense is irrelevant to the study of proper scientific knowledge.

Lakatos supports fully this view, writing that knowledge has no scientific value, unless it is independent of the human mind which creates or understands it [42].

It seems, therefore correct to claim that for both Popper and Lakatos scientific knowledge is by definition objective. Obviously, this asserts more than a mere description. It is clearly normative in character.

The positions of Popper and Lakatos are not equally unequivocal, in so far as the existence of observational and theoretical entities is concerned. Thus, as Hacking [43] points out, Lakatos can be read as a Hegelian, since he bases his arguments for a rational interpretation of scientific activity upon the assumption that knowledge grows, irrespective of what one thinks about truth and reality. Lakatos' problem is to provide a theory of objectivity without presupposing a realist interpretation of science: "it does not matter whether we stress the 'instrumental' aspect of imaginative research programmes .... or we stress the growing Popperian verisimilitude of their successive versions" [44].

As already noted, Lakatos doubts the distinction between theory and observation. Indeed the more he doubted it, the more he became attracted to what Popper calls the "third world". This alleged "third world" in his definition is the Platonic world of objective spirit, the world of ideas [45]. Thus, Barnes' [46] assertion that Lakatos is in harmony with a Platonic idealism, is not without justification.

Conversely, Popper [47] declares emphatically that to him, idealism appears absurd and that "denying realism amounts to megalomania". However he considers this particular belief of his as a conjecture to which no sensible alternative has been offered.

III.3.2 A critique: The dilemma persists.

The following critique will deal mainly with the feature of hypothetico-deductivism which I shall take to be fundamental in this context, namely that of falsificationism [48] and its interconnections with other aspects of this philosophical system.

Falsificationism is considered of primary importance, because what actually permits the exponents of hypothetico-deductivism to reverse the sequence of observation followed by theory construction (on which inductivism is based), is the assertion that one should try to refute theories instead of trying to verify them. This is founded on the contention that the distinction between theory and observation is not significant epistemologically.

It is precisely the latter which undermines hypothetico-deductivism. For as Putnam [49] points out, even if a theory is refuted by an experimental test which takes into account the hypothetico-deductivist position that observations and theories can be equally fallible, the theory may still be correct and the observation false.

Theories therefore, cannot be conclusively falsified, because the observation statements that form the basis for the falsification may themselves prove to be false in the light of later developments [50].

Furthermore, as Newton-Smith [51] and Putnam [52] argue, falsificationists, by stressing the attempted refutations as strongly as Popper has done, give a rather distorted picture of the actual practice of science. More specifically, as their actual practice indicates, "scientists get themselves in the grip of a theory which they aim to develop and defend" [53], not just simply trying to refute it as strongly as possible.

This failure to acknowledge the highly important role of practice [54], which holds falsificationism as inadequate on historical grounds [see note (a) on III.3] [55], led Popper and Lakatos to the idea of a sharp demarcation between science on the one hand and political or ethical ideas on the other. As Putnam [56] points out, this demarcation is rather pernicious. "One does not have to be a Marxist or Freudian to be uneasy about the equation of worthlessness" with their conception of the "unscientific" [57]. To reject a-priori (and in the name of an anti-a-priori philosophy of knowledge) the thought of Marx or Freud, can for instance, blind one to the undoubted insights of these two very influential thinkers.

In conclusion, one could say that despite the "rational" effort to reconstruct the nature of the scientific enterprise and the very useful insights it has offered, hypothetico-deductivism has not solved the problem of the intuitive appeal of induction. Furthermore, it seems to be more remote from actual scientific praxis than the latter.

III.3.3 The hypothetico-deductivistic image: a synopsis.

Summarising, the features science ought to have according to hypothetico-deductivistic account are, as follows:

1. Deductive structure of theories.
2. Methodologically speaking, there is unity in science and the scientific method should attempt to falsify statements deduced from theories in order to falsify the theories, rather than attempt to verify theories.
3. Criteria of demarcation based on falsification. In this point Popper and Lakatos differ (for a fuller account, see section III.3.1).
4. There exists a distinction between theory and observation. This does not mean that observations are in any way privileged vis-a-vis theories.
5. Ontological issues; Popper is a realist which is not quite true for Lakatos.
6. Science grows through a succession of better theories (or research programmes in Lakatosian terminology), each of them being a better approximation of truth than its predecessor.
7. Scientific knowledge is objective and therefore it is intrinsically superior to other non-objective bodies of knowledge.

On the basis of the above points, the following set of statements is offered as representing an hypothetico-deductive image of science. The same qualifications as in the case of inductivism so far as accuracy and simplification are concerned, also apply here. The construction of the part of the research instrument referring to hypothetico -deductivism will be based on these statements.

1. For the different kinds of scientific enquiry there is basically one scientific method.

2. The scientific method is to start by deducing consequences of theories, checking them against the data.

3. When the consequences of a theory are compared with data, sound conclusions can be drawn if and only if theory and data disagree.

4. When there is a debate about whether a given theory is to be regarded as "scientific", there are rational and defensible criteria for making the decisions.

5. When there are competing theories and scientists want to decide between them, there are rational and defensible ways of doing so.

6. In general the better of two competing theories is the one which is nearer to the "truth".

7. To be sure of approaching nearer to the "truth", one should follow the appropriate scientific method.

8. As science changes or develops, new knowledge generally replaces older incorrect "knowledge".

9. New scientific knowledge arises mainly through a succession of more general and more complete theories.

10. The status of scientific knowledge is different from other kinds of knowledge, having a characteristic value of its own.

11. Scientific knowledge has particular characteristics in that it attempts to be an objective account of Nature.

NOTES ON III.3

*(a). Numerous writers (e.g. Chalmers, Putnam, Feyerabend, to mention but a few) have argued that classic new scientific theories have been countered by obsevational claims which were considered to contradict them, and it was science's good fortune that they were not rejected (as falsificationism implies they ought to have been).

BIBLIOGRAPHICAL NOTES.

[1]. see sections III.4 and III.5.

[2]. Hacking, I. (1983), p. 5.

[3]. see section III.6.

[4]. Hacking, I. (1983), p. 44.

[5]. Feyerabend, P. (1975) p. 171; et al.

[6]. Hacking, I. (1983), p. 6.

[7]. Ibid., pp. 4-6.

[8]. Newton-Smith, W. H. (1981), p. 46.

[9]. Popper, K.R. (1979), p. 44.

[10]. Newton-Smith, W. H. (1981), p. 51; Hacking, I. (1983) p. 6; Harre, R. (1972), p. 49.

[11]. Popper, K.R. (1979), p. 72.

[12]. Ibid., p. 44.

[13]. Ibid., p. 44.

[14]. Ibid., p. 46.

[15]. Newton-Smith, W. H. (1981), p. 45.

[16]. Popper, K.R. (1979), p. 44.

[17]. Tarski, A. (1956), pp. 172-278; Tarski, A. (1969), pp. 63-77.

[18]. Harre, R. (1972), p. 49.

[19]. Popper, K.R. (1979), p. 71.

[20]. Ibid., p. 71.

[21]. Newton-Smith, W. H. (1981), pp. 47-48.

[22]. Ibid., p. 47.

[23]. Popper, K. (1979), chapter 1; Hacking, I. (1983), p. 5.

[24]. Lakatos, I. in Lakatos, I. and Musgrave, A. (ed), (1970), pp. 106-109.

[25]. Popper, K.R. (1979), p. 73.

[26]. Newton-Smith, W. H. (1981), pp. 47-48.

[27]. Popper, K.R. (1979), p. 72.

[28]. Newton-Smith, W. H. (1981), p. 49.

[29]. Ibid., pp. 94-95.

[30]. Chalmers, A.F. (1982), p. 40.

[31]. Newton-Smith, W. H. (1981), p. 57.

[32]. Popper, K.R. (1979), p. 109.

[33]. Ibid., p, 53.

[34]. Lakatos, I. (1978a), pp.31-32.

[35]. Ibid., p. 32.

[36]. Lakatos, I. in Lakatos, I. and Musgrave, A. (ed), (1970), p. 106.

[37]. Chalmers, A.F. (1982), p. 87.

[38]. Newton-Smith, W. H. (1981), p. 79.

[39]. Espagnat, B.d' (1983) p. 58.

[40]. Popper, K.R. (1979), p. 108.

[41]. Ibid, pp. 108-109.

[42]. Lakatos, I. in "Boston Studies in the Philosophy of science" vol. 8 p. 99; Lakatos, I. (1978a), p. 1.

[43]. Hacking, I. (1979), pp. 381-402.

[44]. Lakatos, I. (1978a), p. 100.

[45]. Popper, K.R. (1963).

[46]. Barnes, B. (1982), pp. 62-63.

[47]. Popper, K.R. (1979), p. 41.

[48]. Chalmers, A.F. (1982), chapters 4-6.

[49]. Putnam, H. in Hacking, I. (1981) pp. 68-69.

[50]. Chalmers, A.F. (1982), p. 63.

[51]. Newton-Smith, W. H. (1981), p. 74.

[52]. Putnam, H. in Hacking, I. (1981) p. 78.

[53]. Newton-Smith, W. H. (1981), p. 75.

[54]. Putnam, H. in Hacking, I. (1981) p. 78.

[55]. Chalmers, A.F. (1982), p. 66.

[56]. Putnam, H. in Hacking, I. (1981) p. 79.

[57]. Newton-Smith, W. H. (1981), p. 90.

III.4 CONTEXTUALISM: Two interpretations of Kuhn.

The rationalists, following Popper or Lakatos, assert the existence of timeless, universal and therefore a-historical criteria through which the choice between competing theories can be achieved (akin to the position of logical positivists and hypothetico-deductivists).

One critical response to this position stresses the importance of dispassionate examination of the actual history and practice of science in order to formulate an image of science. It is Kuhn and Ziman who argue for the latter.

What seems to distinguish their stance from that of the relativists is the interpretation they attach to these historical and sociological considerations. On the other hand absolute relativists, impressed by the historical and social dimensions of scientific knowledge, conclude that science is merely one ideology among others. Kuhn and Ziman (hereafter referred to as contextualists) use such considerations to explain scientific growth, but they do not resort to an all inclusive relativism. However, in some instances their position has been interpreted as leading finally to relativism or agnosticism.

III.4.1 The main themes: Evolution or revolution.

The central theme in the work of Kuhn is the pattern of scientific change. Needless to say, the usual array of issues in such debates, such as the status of scientific knowledge, the existence and the use of criteria of demarcation and the very role of rationality in science, are clearly connected to and in fact follow from the way one conceives changes in science.

It should be added that the distinction which both inductivists and hypothetico-deductivists forcefully retain between discovery and justification, has no place in Kuhn's account. Within this system, social or even psychological factors influencing the shift of allegiance of scientists from one theory to another, are of great importance; indeed instrumental to the explanation of scientific change [1].

For Kuhn [2], normal science involves scientific activities firmly based upon past scientific achievements which a certain scientific community acknowledges for a time, providing the foundation for its further practice.

A period of normal science is characterised by a paradigm. As Chalmers [3] remarks, the very nature of this concept makes a precise definition elusive. Kuhn, being conscious of such elusiveness, presented in his first version of "paradigm" two elements essential to it. A paradigm, according to him, is an achievement that shares two characteristics:

-it is significant enough to attract a group of scientists away from competing modes of scientific activities.

-it is sufficiently open-ended to leave "puzzle" solving activities for the practitioners to resolve [4].

It is these "puzzle" solving activities which are in a sense central to normal science [5]. Hacking [6] and Losee [7] state that puzzle solving activities, in a Kuhnian context, mean those activities in which research workers try to extend proven successful techniques so as to remove gaps, problems or inconsistencies which exist in an established body of knowledge. In this sense, normal science occupies the conservative end of the spectrum in the scientific enterprise, or as Barnes puts it: "Normal science is ... a process of extending and filling out the realm of the known; it does not look for fundamental novelties" [8].

However, as Kuhn himself concedes in the "Postscript", describing paradigms in such a way introduces a circularity, with a number of difficulties. This is because "a paradigm is what the members of scientific community share and conversely a scientific community consists of men who share a paradigm" [9].

To remove the "vicious" aspects of this circularity, Kuhn elaborates further the notion of paradigm. Thus he introduces a distinction between the use of a paradigm in a broad and in a narrow sense. In a broad sense, a paradigm is a "disciplinary matrix" or "an entire constellation of beliefs, values, techniques and so forth, shared by members of a given community" [10]. For instance, members of a scientific community may share a belief in the existence of certain theoretical entities e.g. fields, genes. Furthermore, these scientists may be in agreement as to which types of reasoning or investigation are important. All these constitute parts of a paradigm in a broad sense. Finally, it should be noted that a paradigm in a broad sense includes one or more paradigms in the narrow sense [11], [12], [13].

In the narrow sense, a paradigm is an exemplar. It aids the scientist confronted with a problem within normal science, to deal with it in the same way as a problem already tackled: "Having seen the resemblance, grasped the analogy between two or more distinct problems, one can interrelate symbols and attach them to nature in ways that have proved effective before" [14].

Hacking [15], looking at the same issue from a slightly different angle, interprets the broad-narrow distinction as either paradigm-as-achievement or paradigm-as-a-set-of-shared-values. Paradigm-as-achievement means the accepted way of solving a problem, which then serves as a model for future workers. The other branch of this distinction contains the methods, standards and concepts which scientists share in order to work within a paradigm-as-achievement model.

One can appreciate better the difference between the above mentioned distinctions if one considers, as Hacking [16] points out, Kuhn's focus on the "internal" study of scientific change. The term internal, in this sense, indicates an intimate and precise knowledge of science in an historical perspective [17], as opposed to the exclusion of all other factors (the Popperian sense of "internal").

However, if "paradigm" (despite its multifarious use and interpretations) and "normal science" are essential for one to understand how science and scientists function in a non-change period of science, it is the notions of "crisis" and "scientific revolution", which complement them in explaining scientific change and growth.

Generally speaking, Kuhn sees the pattern of scientific change [see note (a) on III.4] as a shift from one paradigm (in the broad sense) to another. The obvious question then becomes, why does such a shift occur? Is it because new paradigms answer questions more adequately (inductivists', logical positivists' position)? Alternatively, is it because theories associated with the new paradigm are better than theories found in the old paradigm (Popper-Lakatos)? The answer is clearly negative: such a shift occurs when pressing anomalies emerge, which cannot be solved employing the range of intellectual armoury contained in the old paradigm [18]. This happens because new achievements present new ways of looking at things, which in turn create new problems.

It is this shift from one paradigm to another - involving a period of crisis between two different periods of normal science - which Kuhn terms a scientific revolution. A further element of this revolution is its collective dimension: it is the abandonment of one paradigm for a new one by the relevant scientific community as a whole, and not by an individual scientist [19]; or, as Kuhn more precisely defines it, an "increasing shift in the distribution of professional allegiances" [20], which is important.

Therefore, the Kuhnian schema for scientific change approximates something like:
normal science - crisis - scientific revolution - new normal science [21]. This sequence is continuous and the new normal science is established, after resistance to the paradigmatic change [22] by at least part of the scientific community.

Given the above pattern of scientific change so advocated by Kuhn, a question arises: Is science a cumulative enterprise? In other words does science grow, (as inductivism and hypothetico-deductivism maintain) or is it merely a succession of qualitative changes?

The use of the term "revolution", as opposed to "evolution", begs a number of questions about the character of the transition from a normal period to a subsequent normal period through a scientific revolution.

Does this transition mean discontinuity? And if so, is this discontinuity to be interpreted as indicating that scientific theories embedded in a paradigm are incommensurable with those of the new paradigm? Again, if it is so, why? Or, if the theories integrated into the old and the new paradigm are commensurable, what are the criteria for the evaluation of their merits?

Concerning the first of the above questions, a distinction between normal science and the overall scientific enterprise (including normal science as well as periods of crises and scientific revolution) is necessary.

For normal science, Kuhn [23] says that it is "highly cumulative". Since its aim is the steady extension of the scope and precision of scientific knowledge, its very success depends on the degree to which it is cumulative. The assertion therefore, that normal science is cumulative is not just a description, but lends it a normative character as well.

Things are different however, if one adopts an overall view. In the overall sense, science is not strictly cumulative, since as Hacking [24] has noted, a change of paradigm alters what sort of questions and answers are appropriate. Old answers can lose their importance after a paradigmatic change. Whether they in addition become unintelligible, depends on the answers to the next cluster of questions.

It is the interpretation of the answers in this series of questions which form probably the most controversial aspects of this system of thought. For Kuhn, the abandonment of one paradigm and the adoption of a new one by the relevant professional community, involves a fundamental change in scientists' general outlook, which is likened to a "gestalt" switch. "The scientist with a new paradigm sees differently from the way he had seen before" [25].

The essence, though, of the questions being asked remains unclarified. As Newton-Smith [26] contests, there are two ways in which such a paradigmatic shift may bring about a change in "how a scientist sees things".

Firstly, a paradigmatic shift may be understood as influencing not science and non-science, have no place in the conceptual fabric of this position. Indeed, Barnes [32], who tends to read Kuhn this way, remarks that Kuhnian work "undermines any such demarcation" and "consequently frustrates the grand undertaking of separating 'reason' from 'unreason'". This is in contrast with Lakatos' point of view [33] who maintains that if science changes through scientific revolutions, then it is insufficiently determined by "rules of reasons" [see note (b) on III.4].

If however theories cannot be compared and their relative merits cannot be judged against each other, one is then asked to accept relativism, which implies that one has no right to see scientific change as scientific growth. For instance, according to relativism, one cannot and therefore should not claim that relativistic mechanics can be compared in any sense with Newtonian mechanics, nor as a matter of fact, with Aristotelian mechanics. Clearly, Kuhn was not prepared to accept such a far reaching conclusion (e.g. "...my view of scientific development is fundamentally evolutionary", and "one scientific theory is not as good as another for doing what scientists normally do" [34]), despite the fact that some of his remarks and terminology (e.g. revolution as opposed to evolution, world view change) laid the ground for an argument favouring relativism.

Kuhn, apart from taking into account social and historical factors to explain scientific change, argues that the built-in anomalies in the case of normal science are at least equal in importance to other (external) factors in initiating a paradigmatic shift [35]. This leads to the second and probably more acceptable way of understanding this philosophical system. Within this system, incommensurability means that after a scientific revolution has taken place, the new paradigm emerging may address new problems employing new concepts [36], yet scientific change is considered as progress: "We must explain why science - our surest example of sound knowledge - progresses as it does, and we must find out how, in fact, it does progress" [37]. Furthermore, because "later scientific theories are better than earlier ones for solving puzzles [see note (c) on III.4] in the often quite different environments to which they are applied" [38] a set of characteristics of good scientific theories is laid down. Roughly speaking a "good" scientific theory should:

-be accurate and precise within its relevant field, only the way of describing things, but affecting also where and how one looks for things. "I have so far argued only that paradigms are constitutive of science. Now, I wish to display a sense, in which they are constitutive of nature as well....Practising in different worlds, the two groups of scientists see different things when they look from the same point in the same direction" [27].

Secondly, this change could be conceived as affecting the way of describing the objects - sources of human experience [28]. "Again, that is not to say that they (i.e. the scientists in competing paradigms) can see anything they please. Both are looking at the world and what they look at has not changed" [29].

It would be misleading and unjust to the Kuhnian position to treat the above distinction as a clear cut dichotomy, as it entails an internal contradiction. Obviously, Kuhn shifting from the first to the second position and using both, has tried to dialectically synthesise them. Nevertheless, because this presumed intention is not explicitly stated, one is entitled, stretching the argument a bit, to claim as in fact Newton-Smith did, that one can discern two versions of Kuhnian thought, fairly close to one another. In Newton-Smith's colourful terminology, one can view Kuhn as "temperate irrationalist" (first version) and Kuhn as an "embryonic rationalist" (second version) [30].

The first of the above versions implies that the process of scientific change is marked by discontinuities. As the scientific community leaves one paradigm (which characterises a certain period of normal science) for a new one, it abandons the scientific theories embedded in the old paradigm and it accepts other theories compatible with the new paradigm. These two sets of scientific theories are incommensurable. Therefore, one has no grounds for claiming that a relatively rational evaluation is possible or even conceivable, because in a case such as the above, there are no objective, theory-independent principles against which the theories can be compared: "The normal scientific tradition that emerges from a scientific revolution is not only incompatible but often actually incommensurable with that which has gone before" [31].

Obviously, notions about the existence of criteria for choosing between competing scientific theories, or even demarcating between

-be consistent internally as well as with other currently accepted relevant scientific theories (external consistency),

-have broad scope so as to cover as many phenomena, observations or sub-theories as possible within the paradigm it is functioning,

-be simple, e.g. by determining the values of universal constants,

-be fruitful, i.e. provide new research findings and formulate quantitative laws which further articulate the relevant paradigm [39].

These characteristics resemble five paradigm independent criteria for deciding between competing theories [40]. Two remarks seem pertinent here. Firstly, appealing to the above criteria-like characteristics does not resolve the problem of choosing between theories which are partially heteromorphic (i.e. the first theory has the first three characteristics, while a second complies with the last two of them). In such cases, scientific changes ought to be accounted for by external factors. Secondly, and more importantly, one should always bear in mind that for Kuhn, theory choice in the face of a body of evidence, does not mean following a system of binding rules [41]. Therefore, the above set of characteristics resembles a set of criteria but they do not constitute criteria themselves. Strictly speaking, if one has to speak of criteria "What better criterion than the decision of the scientific group could there be?" [42]; or, as Ziman [43] puts it, the consensus of the relevant scientific community arising out of critical scrutiny, constitutes the criteria. This consensus should take into account the characteristics which each scientific theory ought to have, as well as social and historical factors.

Regarding this, Kuhn [44] has put forward in the "Postscript" a number of questions referring to the acquisition of membership of a particular scientific community, the stages of socialisation for the individual member to the group, the degree of tolerance concerning individual and collective deviation, etc.

Finally, to put the Kuhnian thought in perspective, it should be noted that while this system differs from an inductivistic or hypothetico-deductivistic account of science (mainly by introducing social and historical considerations, as factors influencing the way science changes), it differs dramatically from the relativistic standpoint (expressed by Feyerabend who denies that there is any sort of system of rules "running through the historically evolving scientific community" [45]), as well.

III.4.2 A critique: The fundamental tension.

As is evident from the above, the notion of paradigm is central to the Kuhnian system. It permeates this system so deeply, so as to give one justifiable grounds for arguing that every aspect of this position (e.g. normal science, crisis, scientific revolution, the way science changes) either follows or is closely connected to the way one defines the concept of a paradigm. One way, therefore to discuss the possible merits or weaknesses of this stance, is to focus the critique on the way paradigms are defined.

Restating the previous discussion, one can emphasise two points:

-firstly, Kuhn's concession that paradigm is elusive in terms of a precise definition,

-secondly, the distinction between paradigm in a broad and in a narrow sense.

Attempting to defend the legitimacy of the application of a term (e.g. paradigm) whose meaning can only be intuitively grasped, Kuhn invokes Wittgenstein's [46] argument that one can learn how to employ a term, even if there is no set of characteristics which "is simultaneously applicable to all members of the class described by the term and to them alone" [47]. It is a network of overlapping and interlocking similarities, which help identify a term. For instance, a game activity is characterised as such, because when we are first confronted with it, we recognise its close resemblance to other activities previously known by that name.

However, even having accepted the use of the term paradigm in a "loose" fashion, in addition to the distinction between the use of paradigm in a broad and narrow sense, it does not follow that one is entitled to shift back and forth between the broad and the narrow sense of paradigm. Shapere [48], criticising Kuhn, has pointed out exactly this.

Obviously, one should not underestimate these criticisms in terms of academic rigour and clarity. This does not however mean that the very substance of the Kuhnian thesis, in conceding lack of precision, is weakened beyond defence.

Thus, with respect to the more substantial aspects of this position, certain philosophers (such as Popper [49] and Lakatos [50]), rejecting the inclusion of factors other than internal ones to account for changes in science (e.g. social ot historical factors), focus their criticism in this direction, saying that the Kuhnian pattern renders scientific change a matter of "mystical conversion".

A fair evaluation of their criticisms can be conducted in the light of Masterman's [51] analysis of Kuhn's different conceptions of a paradigm. As a matter of fact, in her paper, Kuhn's explanations of the meaning of paradigm, or use of term, were counted and found to number twenty one in total [see note (d) on III.4]. This does not mean, as she acknowledges, that these "paradigms" are inconsistent with each other. Looking for common ground between all the senses in which the term was applied by Kuhn, Masterman found three broad categories:

-philosophical paradigms or metaparadigms, e.g. an organising principle governing perception;

-sociological paradigms (sociological considerations are of primary importance), e.g. paradigm as an accepted judicial decision regarding scientific disputes,

-and finally, artefact or construct paradigms (more psychologically oriented) e.g. paradigm as analogy.

Turning back to the rationalists' criticism of Kuhn's account of science, and given their explicitly declared position that only the context of justification of scientific theories is the legitimate field of philosophy of science, it is obvious that they focus on the philosophical sense of paradigm. What however remains as their starting point to build their argument, is Kuhn's use of paradigm in the sociological or psychological senses. In other words, their main objection lies with the introduction of what they call external factors (sociological and/or psychological considerations) to the debate. Their position does not seem to assist any attempt to form an integrated, "holistic" image of science.

It is Feyerabend [52], who revealing another ambiguity addressed another serious problem. He asked whether a paradigm presents one with a methodological prescription or only a mere description "void of any evaluative elements". In a sense, this question is connected with Newton-Smith's claim which discerns two versions of the Kuhnian system. This tension constitutes the most fundamental aspect of the issues undergoing criticism.

In conclusion then, it can be said, that this tension, once discerned, provides good reason for the treatment of each version as a separate philosophical system. It should be added that the postulates of the second version are very close to the theoretical assumptions adopted in the present thesis (with the exception of the issue of reality), and will be analysed in a later chapter.

III.4.3 The Kuhnian images of science.

As already argued, Kuhnian thought can be interpreted as presenting two alternative images of science. Their main difference lies in the way in which the role of rationality in science is conceptualised by each of them.

The first version is more relativistic in character. Discussing in this light the positions entailed with regard to

(a) scientific method,

(b) pattern of scientific growth,

(c) criteria of demarcation and

(d) status of scientific knowledge,

one can say that:

(1) there is no unity in terms of scientific method; furthermore, the choice of a certain method for a given problem is not completely a rational exercise;

(2) the pattern of scientific change as opposed to growth, is a never ending sequence of: normal science - crisis scientific revolution

- new normal science, occurring through paradigmatic shifts. The notion of incommensurability and the interpretation that the old and the new paradigm are absolutely non-comparable are relevant here;

(3) the very notion of criteria of demarcation is rendered inoperable. One has no justifiable grounds for choosing one paradigm (which, in this sense determines the sort of knowledge) against another;

(4) scientific knowledge has no special status, since there is no basis for this claim. This version does not differ from relativism. For this reason, a more extensive discussion of it and its possible variations, will be included in the next section.

The main points of the second possible version of a Kuhnian image of science are as follows:

(1) there is no unity in terms of scientific method; however, there are rational criteria for choosing between the available methods for a given problem;

(2) the pattern of scientific growth is a never ending sequence of normal science - crisis - scientific revolution - new normal science, occurring through paradigmatic shifts. The old and new paradigms are incommensurable. In this instance, incommensurability is taken to indicate, not complete non-comparability, but rather the fact that the old and the new paradigms address different kinds of problems;

(3) one can distinguish science from non-science, or choose between competing scientific theories. This is not to say however, that this choice is a sort of algorithmic procedure. It rather arises out of critical scrutiny and debate among the members of the relevant scientific community, according to some general principles which indicate the traits to which an acceptable scientific theory ought to comply;

(4) scientific knowledge has a special status in that it is the surest sort of knowledge.

Finally, it should be added that regarding the continuum whose end points are realism and idealism, the location of either of these two versions is open to debate. Nevertheless, as Newton-Smith [53] remarks, Kuhn himself is not a realist and this irrespectively of the version of his system which one chooses.

III.4.4 Representing the Kuhnian image of science: Two sets of statements.

In the following, two sets of statements are presented. The first is intended to represent the first version of Kuhnian thought ("moderate irrationalist") while the second is intended to encapsulate the second version ("embryonic rationalist"). Again, a degree of simplification is acknowledged.

III.4.4.1 First image: Contextualism A.

1. For the different kinds of scientific enquiry there are different ways of being scientific in terms of method.

2. In choosing between different scientific methods for a given problem there are standards enabling a reasonable choice to be made.

3. The existence of various incompatible scientific methods is a fruitful source of scientific progress.

4. In general the choice of the appropriate method to be used for a given problem is guided by a consensus of the scientific community.

5. When there are competing theories (belonging to different paradigms) and scientists want to decide between them there are no rational and defensible ways of doing so.

6. The search for general rules for deciding either between competing scientific theories or which one of them deserves to be called scientific is pointless because when theories change, so do our ideas about how to decide between theories.

7. As science changes or develops, new knowledge generally replaces knowledge of another sort.

8. New scientific knowledge either fits within the existing framework, or generates a new framework incompatible with the old one.

9. The status of scientific knowledge is not different from that of any other kind of knowledge, all kinds having equal validity.

III.4.4.2 Second image: Contextualism B.

1. For the different kinds of scientific enquiry there are different ways of being scientific in terms of method.

2. In choosing between different scientific methods for a given problem there are standards enabling a reasonable choice to be made.

3. When there is a debate about whether a given theory is to be regarded as "scientific" there are rational and defensible criteria for making the decision.

4. The existence of various incompatible scientific methods is a fruitful source of scientific progress.

5. In general the choice of the appropriate method to be used for a given problem itself belongs within the concept of science.

6. The search for general rules for deciding either between competing scientific theories or which of them deserves to be called scientific is not pointless.

7. As science changes or develops, in some periods new knowledge replaces ignorance or lack of knowledge while in other periods new knowledge replaces knowledge of another sort.

8. New scientific knowledge either fits within the existing framework, or generates a new framework incompatible with the old one.

9. The status of scientific knowledge is different from other kinds of knowledge, having a characteristic value of its own.

10. Scientific knowledge has particular characteristics in that it is a systematic pattern of thought.

NOTES ON III.4

*(a). the use of the term change, as opposed to growth is deliberate.

*(b). "Insufficient" in this system of thought means not exclusively determined by "rules of reason".

*(c). It should not be forgotten that solving puzzles (removing anomalies, increasing the scope et al.) is for Kuhn the main goal of normal science.

*(d). To refer to each one of them, although interesting, is out of the scope of this thesis.

BIBLIOGRAPHICAL NOTES.

[1]. Kuhn, T.S. (1977), pp. 321-322; Barnes, B. (1982) pp. 41-42.

[2]. Kuhn, T.S. (1970), p. 10.

[3]. Chalmers, A.F. (1982), p. 91.

[4]. Kuhn, T.S. (1970), p. 10.

[5]. Hacking, I. (1983), p. 7.

[6]. Hacking, I. in I. Hacking (ed.) (1981), p. 2.

[7]. Losee. J. (1980), p. 204.

[8]. Barnes, B. (1982) p. 46.

[9]. Kuhn, T.S. (1970), p. 176.

[10]. Ibid., cited by J. Losee (1980), p. 206.

[11]. Ibid., p. 43.

[12]. Chalmers, A.F. (1982), pp. 90-91.

[13]. Losee, J. (1980), p. 207.

[14]. Kuhn, T.S. (1970), p. 189.

[15]. Hacking, I. in I. Hacking (ed.) (1981), pp. 2-3.

[16]. Ibid., p. 5.

[17]. Kuhn, T.S. (1977), pp. 320-339.

[18]. Kuhn, T.S. (1970), pp. 80-81.

[19]. Chalmers, A.F. (1982), p. 97.

[20]. Kuhn, T.S. (1970), p. 158.

[21]. Hacking, I. in I. Hacking (ed.) (1981), p. 2.

[22]. Chalmers, A.F. (1982), pp. 98-99.

[23]. Kuhn, T.S. (1970), p. 52.

[24]. Hacking, I. in I. Hacking (ed.) (1981), p. 3.

[25]. Kuhn, T.S. (1970), p. 115.

[26]. Newton-Smith, W.H. (1981), p. 117.

[27]. Kuhn, T.S. (1970), p. 110.

[28]. Newton-Smith, W.H. (1981), p. 118.

[29]. Kuhn. T.S. (1970), p. 150.

[30]. Newton-Smith, W.H. (1981), p. 124.

[31]. Kuhn, T.S. (1970), p. 94.

[32]. Barnes, B. (1982), p. 59.

[33]. Lakatos, I. in I. Lakatos and A. Musgrave (eds) (1970), p. 93.

[34]. Kuhn. T.S. in I. Lakatos and A. Musgrave (eds) (1970), p. 264; Kuhn, T.S. (1977), pp. 324-325.

[35]. Kuhn, T.S. (1970), p. 69.

[36]. Hacking, I. in M. Hollis and S. Lukes (eds) (1982) p. 59.

[37]. Kuhn, T.S. in I. Lakatos and A. Musgrave (eds) (1970), p. 20.

[38]. Kuhn, T.S. (1970), p. 206.

[39]. Kuhn, T.S. (1977), pp. 321-322.

[40]. Newton-Smith, W.H. (1981), p. 113.

[41]. Ibid., p. 116.

[42]. Kuhn, T.S. (1970), p. 170.

[43]. Ziman, J. (1968), p. 135.

[44]. Kuhn, T.S. (1970).

[45]. Newton-Smith, W.H. (1981), p. 122.

[46]. Wittgenstein, L. (1953), pp. 31-36.

[47]. Kuhn, T.S. (1970), p. 45.

[48]. Shapere, D. in "Phil. Rev." 73 (1964) pp. 383-394.

[49]. Popper, K. in I. Lakatos and A. Musgrave (eds) (1970), pp. 56-57.

[50]. Lakatos, I. in I. Lakatos and A. Musgrave (eds) (1970), p. 93.

[51]. Masterman, M. in I. Lakatos and A. Musgrave (eds) (1970), p. 63.

[52]. Feyerabend, P. in I. Lakatos and A. Musgrave (eds) (1970), p. 198.

[53]. Newton-Smith, W.H. (1981), p. 124.

III.5 RELATIVISM : A libertarian view.

The relativist denies the existence of universal and a-historical standards of rationality, which could enable scientists to choose between competing scientific theories [1]. On the contrary, he accepts that judgements of the merits or weaknesses of a particular theory, will vary from individual to individual or from community to community, or from culture to culture.

This view has a number of serious consequences, in terms of how one perceives the function and usefulness of science, and has of course profound educational implications. Before setting out to discuss these consequences, it should be noted that relativism is more popular among sociologists of science [see note (a) on III.5] as opposed to philosophers of science, although one of the more interesting accounts of scientific practice has been produced by Feyerabend, an ardent follower of this stance in the philosophical context.

In the following section, an account and a critique of philosophical relativism as expressed by Feyerabend is attempted. Subsequently, the implications of this approach from an educational standpoint as well as in the wider philosophical context will be briefly considered.

III.5.1 The main thesis: "Anything goes".

For Feyerabend, ultimately, science represents no more than one ideology amongst others [3]. It should be noted that he does not use the term ideology in any strictly defined sense, but rather interchangeably with other terms like theory, tradition and world-view.

Two themes provide the foundations to Feyerabend's above-mentioned claim. Roughly speaking, one can encapsulate these in:

-the assertion that "anything goes", regarding the methods employed by science;

-the notion of incommensurability of scientific theories.

The first theme would appear to be an attack on the account of scientific method provided by inductivists and hypothetico-deductivists. The issue at stake, in Feyerabend's terms, is not what the scientific method should be - he in fact denies the very notion of scientific method [4], arguing that methodological debates have failed to provide adequate guiding principles for practising scientists [5]. Furthermore, he challenges on a deeper level the legitimacy of investigating "the" scientific method; as in his view, it is not only unrealistic to attempt to explain the complex interactions involved in the history of science, in terms of certain methodological rules, but also pernicious and detrimental to both society in general and science in particular [6].

Science would be affected because "there is no idea, however ancient and absurd, that is not capable of improving our knowledge" [7] and therefore harnessing scientific activities to the limitations and rules that are implied by all methodologies does nothing else but making "science less adaptable and more dogmatic"[8]. Society, on the other hand, permitting a dogmatic science to prevail, which subsequently overcomes other ideologies (e.g. religion, magic, to name but a few), does nothing more than restrict the freedom of its individual members [9].

Having dealt with an outline of Feyerabend's methodological position, his strategy for the case "against method" will next be examined. His target is to undermine the faith in rules of evidence, arguing that for any such rule, an equally defensible counter-rule exists; the counter-rule leading to exactly opposite results [10].

Here, Feyerabend refuses to accept that something could provide grounds for accepting one scientific theory rather than another - something, "which would be a reason for any individual regardless of his own ideological perspective "[11]. In this, he rejects two cardinal distinctions (for the followers of the Vienna circle): the distinction between observation and theory and the distinction between the contexts of discovery and justification of scientific theories [see note (b) on III.5].

Consider for instance Feigl's [12] distinction: "It is one thing to retrace the historical origins, the psychological genesis and developments, the socio-politico-economic conditions for the acceptance or rejection of scientific theories; and it is quite another thing to provide a logical reconstruction of the conceptual structure and of the testing of scientific theories". As Dolby [13] has pointed out, this principle of the Vienna Circle provides the demarcation line between philosophy (dealing with the latter part of this distinction) and sociology (the former part constituting its field) of scientific knowledge, for logical empiricists and hypothetico-deductivists.

For if the ideological perspective of the individual scientist is the determinant of his allegiance to a certain scientific theory, then the distinction between theory and facts (the facts being a means for testing in one way or another the theories) loses its meaningfulness. Or, as Feyerabend claims, the only distinction between theories and facts is that "facts are constituted by older ideologies" [14].

Furthermore, if one agrees with Feyerabend's assertions about the nature of scientific theories (and facts), it is clear that the second of the above mentioned distinctions plays no role in scientific practice. Firstly, because one lacks any instrument to test the theories (i.e. facts in other philosophical systems) and secondly, because beliefs do not constitute the most appropriate domain for the application of purely rational and therefore emotionally detached arguments [see note (c) on III.5].

To undermine then, the faith in the role of rules of evidence for accepting or rejecting a certain scientific theory, and having prepared the background by abolishing the two distinctions (between theory and facts and between context of discovery and context of justification), Feyerabend argues for a replacement of what he terms the principle of consistency, with a counter-inductive schema [18].

This counter-inductive schema entails that the way which does not restrict scientific progress is through a proliferation of theories at odds with currently accepted theories; "hypotheses contradicting well confirmed theories, give us evidence that cannot be obtained in any other way" [19]. This tenet of the proliferation of scientific theories constitutes, obviously, a part of the pattern for scientific change suggested by Feyerabend; the other part being the notion of incommensurability to be discussed later.

It appears that two distinctions are necessary in clarifying the treatment of the principle of consistency within this philosophical system.

-(a): the principle of consistency (which according to Feyerabend, traditional philosophers of science hold) versus internal consistency (of an argument or of a theory)

-(b): the principle of consistency per se, as opposed to its justification.

Regarding the former, it is obvious that Feyerabend does not oppose internal consistency (coherence), when he rhetorically asks: "what is wrong with inconsistencies?" [20]. On the contrary he regards any internal inconsistency contained in a certain position, as sufficient reason to abandon that position [21].

As far as the latter is concerned, it should be considered in the light of Feyerabend's justification for giving preference to a counter-inductive schema (in order to explain scientific change) rather than in the light of his version of the principle of consistency [see note (d) on III.5].

Thus, arguing for this substitution, Feyerabend invokes the history of science to substantiate his thesis. His argument, roughly speaking, proceeds as follows: any scientific argument (for instance, the Aristotelian tower argument which was used to refute the motion of earth) involves interpretation of observation closely connected with the currently prevailing theories. Therefore, the first step is always to find the principles embedded in observational notions. Having disentangled the implicit old theoretical notions from the relevant observations, one can express observations using a new observational language, which obviously is sustained by a number of implicit theoretical ideas taken from the new theory being proposed [23].

To illustrate this point, Feyerabend quotes an excerpt from Galileo. In this, Galileo inverted a version of the tower argument in order to replace the observational language used in the initial characterisation of the experience, with a different observational language. By doing so, he rendered the theoretical conceptions implicit in the old observational language inoperative, thereby preempting their replacement.

Feyerabend construes this as being not a confrontation with facts which leads one to move from one scientific theory to another, because at the time of Galileo, the evidence (i.e. facts) available did not by any means, favour the then new Copernican theory vis-a-vis Aristotelian mechanics, on which the Ptolemean astronomical system was based. So, why did Galileo's view prevail? In Feyerabend's account, other factors, extraneous to the principle of consistency made the difference (e.g. the style and the artful use of persuasion, the use of Italian instead of Latin and the appeal to an audience attracted to new ideas [24].

Clearly, what follows from such an interpretation, is that the principle of consistency as stated in a normative fashion by Feyerabend, cannot account for changes in scientific theories.

Turning back to the distinction between this principle and its justification, it is interesting to note that Feyerabend conceded the possibility of it being used to logically reconstruct the course of science, providing that it is not expressed in strong normative terms, i.e. hypotheses not concurring with accepted theories should be abandoned immediately (Feyerabend's reading of Lakatos' distinction between progressive and degenerating scientific programmes) [25]. He insists however, that in this case its justification through an appeal to reason is impossible: "in so far as the methodology of research programmes is rational' it does not differ from anarchism [see note (e) on III.5]. In so far as it differs from anarchism, it is not 'rational'" [26].

One further reason rendering any attempt at such a reconstruction futile is that by definition any such attempt is retrospective. Feyerabend's [28] position, on the other hand, is that any proposed reconstruction should be based on the evidence available at the time of theory confrontation, if to be of normative use.

Looking at Feyerabend's argument "against method", and more particularly at his attack on the principle of consistency, as a principle guiding scientific change, one can discern amongst its basic starting points, the tenet of the theory-dependence of observations i.e. that observation statements will depend on the theoretical context in which they occur, because they carry implicit theoretical concepts relevant to this context.

The other main component of Feyerabend's system of thought is the notion of incommensurability of rival scientific theories. As already stated, in the section on contextualists (Kuhn and Ziman), Kuhn's notion of incommensurability is that of scientific theories not addressing the same kind of problems, not employing the same conceptual fabric and finally serving different kinds of functions. Feyerabend's interpretation of incommensurability is far more radical; it entails a fundamental shift in the way of thinking, the general outlook. His favourite example of incommensurability can be found in the break between the cosmologies of the archaic period (8-9th cent. B.C.) and classical Greece [29].

The contrast between Kuhn's and Feyerabend's interpretations of this notion can be seen as helpful towards the demarcation of their positions. It is however the relationship between the way the above authors employ incommensurability and Quine's thesis on the indeterminacy of translations, which may help us to understand better the roots of relativism as well as its inevitable tendencies forwards to scepticism.

Roughly speaking, Quine holds that there are an indefinite number of possible but mutually incompatible translations between two languages, let us say A and B, spoken by two actually disparate linguistic communities. It is not a matter of technical, so to say, difficulties, which could be overcome. On the contrary, it is a matter of principle. To illustrate the point, let "a" be a sentence taken from A; one can translate it by a certain system of translation into "b1" of B. Furthermore, the same sentence "a" can be translated by another system of translation into "b2" of B. According to Quine's position, apart from the possibility of transforming "a" into either "b1" or "b2", "b1" and "b2" are mutually incompatible [30].

Feyerabend suggested that incommensurability should be understood in terms of translation between disparate systems of thoughts. Now, comparing Quine's thesis on the indeterminacy of translation (supposing disparate languages to be disparate systems of thoughts, as well) and Feyerabend's idea of incommensurability, one can see that, in terms of the confidence one can have in a body of knowledge, they lead towards similar ends, despite the fact that they entail different processes towards these ends.

As a matter of fact, indeterminacy says that there is an indefinite number of possible but mutually incompatible ways of moving from one conceptual schema to another disparate one, while incommensurability, in Feyerabend's sense, says there is none at all.

Despite, therefore, this phenomenological discrepancy both lead to similar sceptical claims. If too many mutually incompatible ways of translating propositions from one system of thought to another (for instance, in the scientific context, from Aristotelian to Newtonian mechanics), are available, then one lacks any sound ground for their relative evaluation, and therefore only scepticism is a secure resort. Conversely, if there is no way of communication between systems like the above mentioned, one cannot but retreat to scepticism.

At this point, given the consequences of relativism, not only for scientific enterprise per se, but for science education as well, a taxonomy of forms of relativism will be developed, in the hope that distinctions between the various forms of relativism can help not only to pinpoint the basic assumptions of Feyerabend's thought, but to further demarcate his position from both Kuhnian philosophy and other relativistic trends.

Hollis and Luces [31] distinguish five forms of relativism: moral relativism, conceptual relativism, perceptual relativism, relativism of truth and relativism of reasoning. As Barnes and Bloor suggest the basic starting points of relativistic doctrines are:

(a). the claim that beliefs on a certain topic vary and

(b). the assertion that "which of these beliefs will be found in a certain context, depends on, or is relative to the circumstances of the users" [32].

However, these assumptions are shared by each form of relativism; thus, they can be distinguished by a third feature, namely the "equivalence" postulate.

There are three alternative versions of this postulate. One can either hold that all beliefs are equally true, or that all beliefs are equally false, or that all beliefs are on a par with one another regarding the sources of their credibility. Barnes and Bloor [33] point out that the first two alternatives run into considerable difficulties, being in a sense, as Popper and others argue [34], self contradictory. For instance, to say that all beliefs are equally true, one encounters the problem of how to handle beliefs which contradict one another. Conversely, to say that all beliefs are equally false casts the status of relativists own claims in a dubious light (Zenon s problem).

Clearly, Kuhn and Feyerabend's notion of incommensurability is based on the third version of the equivalence postulate. Asserting that all beliefs are on a par with one another, with regard to the foundations of their credibility, one is undoubtedly subscribing to conceptual and perceptual relativism. What remains then, is the question to what extent relativism of reasoning is involved. This seems to be the point at which the systems of Kuhn and Feyerabend diverge. While Kuhn [35] is not prepared to accept relativism of reasoning (at least the first of the two versions of Kuhnian thought, identified in the previous chapter), Feyerabend appears most content with this form of relativism, by emphasising the extreme and focusing on the significant shifts of human thought (as opposed to the lack of common measures).

To summarise, it could be said that Feyerabend's notion of incommensurability differs from Quine's thesis of the indeterminacy of translation (which holds that no communication of thinking is possible as opposed to excessive interpretations) and from the Kuhnian notion of incommensurability (first version [36]), since it involves relativism of reasoning. Bearing this in mind, any attempt to connect Feyerabend's system of thought with the sort of relativism emanating from linguistic considerations (e.g. Wittgenstein s language games [37]), appears to be most risky. The need for caution becomes stronger if one takes into account that both Quine and Wittgenstein

- spoke of absolutely closed systems; furthermore,
- relativism emanating from linguistic considerations is more akin to logical positivism (early Wittgenstein, Carnap) of which Feyerabend is a great adversary.

III.5.2 A critique: does "anything goes" mean that in practice "everything stays"? [38].

A critique of Feyerabend's system of thought could be discussed from two different angles: either by focusing on those criticisms that reveal internal tensions and weaknesses in his position (which is legitimate even in his own terms), or more generally by trying to ascertain what his position means for organised knowledge, social and particularly physical sciences.

With regard to the first, Feyerabend concedes that science has made "marvellous practical achievements" [39]. If this is the case, one could argue that science is privileged vis-a-vis other forms of knowledge, even if its practice is far removed from the description of other philosophical systems [40]. In response to this, Feyerabend might argue that to support any such claim one would have to show:

(a) that no other view has anything comparable, and

(b) that the results of science are autonomous in the sense that they do not take on any of the features specific to nonscientific traditions [41].

As far as the first claim is concerned, Newton-Smith [42] has asked "what is wrong with the obvious answer that the other traditions fail to thrive for the simple reason that men came to perceive correctly that they were not delivering the goods?". If we accept that "the apostles of science were the more determined conquerors and that they materially suppressed the bearers of alternative cultures" [43], one could ask "how did the apostles of science come to have this alleged power to suppress other traditions?" [44]. Unfortunately, Feyerabend gives no detailed account of such an event. Therefore, in the absence of any supportive argument there is reason to suppose that even if alternative traditions were competing with science on an equal basis, the scientific tradition would triumph by virtue of its fruits [45]. If this is speculation it would seem that Chalmers' remark is more convincing [46]: "We are simply not in a position to have a free choice between science and voodoo, or western rationality and that of the Nuer tribe". Freedom of choice in this respect is as illusory as the choice between pollution and industrial goods.

Turning to (b), as Newton-Smith remarks "why should the facts that arose from such sources (i.e. non-scientific traditions) detract from the success claims of science"? [47]. The salient point here is that the scientific tradition has evolved methods for evaluating and even successfully developing such primitive beliefs. As Chalmers argues [48], Feyerabend has done nothing to provide a detailed study of voodoo "which could reveal that they have well defined terms and methods of achieving those ends", so as to remove one s prejudice, conceding the existence of prejudice. Furthermore, the status of astrology and the like is not a pressing problem in our society at present, such as to cast doubt on our surest example of organised knowledge. In other words, Feyerabend's critique of science is at least misdirected.

Of much more importance than the criticism above is one which examines relativism in its extreme form, from a different angle. It seems that Krige [49] summarises it most aptly, asking "does "anything goes" mean that in practice "everything stays" ?". Taking Feyerabend's assertion that "anything goes" in its normative sense, (as it is intended to be taken), would mean that everyone should follow his individual inclinations. If however, this view is adopted, it is liable to lead to a situation in which those who already have access to power, knowledge, etc. will maintain it. Although this may not be relevant to scientific practice for the simple reason that scientists do not usually look at epistemology for guidance in their practice, nonetheless it has considerable implications for education. This is related to the point made earlier, that an analysis of scientific knowledge along philosophical and/or sociological lines has probably no immediate impact on the way science is practised, but it is highly pertinent to the way science is taught.

Out of relativism a completely different set of principles emerges, regarding the way of selecting, presenting and teaching science. If there is no way of establishing the privileged position of what is usually called "Western science" (a term which is considered to be not quite appropriate in the context of this thesis), then the only criterion for the above functions is that of social relevance. This in turn could lead to one science curriculum for, say, working class children, or blacks, or women and another one for middle and upper class children, or whites, or men. Given that certain groups are de facto privileged in society (and one could argue that middle and upper classes are privileged vis-a-vis the working class), then the construction of a working class curriculum could serve to deny these children access to the sort of knowledge which by virtue of its outcomes is a tool of social hegemony. This is not to deny that other factors could interfere in the establishment of this privileged status.

III.5.3 A depiction of relativism.

The set of statements below, as before, is an attempt to encapsulate the relativistic image of science. The construction of the research instrument referring to relativism will be based on these statements.

1. For the different kinds of scientific enquiry there are different ways of being scientific in terms of method.

2. In choosing between different scientific methods for a given problem there is no rational way of choosing, other than preference.

3. The existence of various incompatible scientific methods shows the pointlessness of discussions about scientific method.

4. In general the choice of the appropriate method to be used for a given problem is made by individuals, using their own critical standards.

5. When there is a debate about whether a given theory is to be regarded as "scientific" there are no rational and defensible criteria for making the decision.

6. When there are competing theories and scientists want to decide between them there are no rational and defensible ways of doing so.

7. The search for general rules for deciding either between competing scientific theories or which one of them deserves to be called scientific is pointless because science merely persuades us to look at things in a certain way, which is no better than any other.

8. As science changes or develops, new knowledge generally replaces knowledge of another sort.

9. New scientific knowledge follows no pattern of growth, being purely the result of what scientists happen to have done.

10. The status of scientific knowledge is not different from that of any other kind of knowledge, all kinds having equal validity.

NOTES ON III.5

*(a). Barnes [2] commenting on the consequences of relativism writes:
"What then of the problem of relativism? The first thing to be said is that whatever conclusions are reached on the matter should not count against the preceding discussion ....one does not turn back because its consequences prove unpleasant".

*(b). For logical empiricism (Popper and Lakatos retain this distinction, too) a blurring of the processes of discovery and justification of scientific theories falls just short of committing a sin.

*(c). As Lakatos [15] writes, for a Popperian, commitment is an unavoidable biological weakness to be limited as far as possible. For Marxists on the other hand, who retaining the objectivity of scientific knowledge espouse commitment [16], one's ideology is determined mainly by social factors (e.g. social class [17]).

*(d). As Newton -Smith [22] points out Feyerabend is attacking a very weak version of this principle. A more sophisticated version should proceed as follows: "All things being equal, new theories should agree with the observationally successful aspects of currently accepted acceptable theories".

*(e). Feyerabend means his own position because he was a self-styled epistemological (as opposed to political) anarchist, or more precisely (again his own qualification) dadaist [27].

BIBLIOGRAPHICAL NOTES.

[1]. Chalmers. A. F. (1982), p. 102.

[2]. Barnes, B. (1977), p. 25.

[3]. Feyerabend. P. (1975), p. 284.

[4]. Newton-Smith, W. H. (1981), p. 125.

[5]. Chalmers, A. F. (1982), p. 134.

[6]. Feyerabend, P. (1975), p. 295.

[7]. Ibid, p. 47.

[8]. Ibid, p. 296.

[9]. Feyerabend, P. (1978).

[10]. Feyerabend, P. (1975), p. 29.

[11]. Newton-Smith, W. H. (1981), p. 127.

[12]. Feigl, H. (1970), p. 4.

[13]. Dolby, R. G. A. (1971), p. 5.

[14]. Feyerabend, P. (1975), p. 55.

[15]. Lakatos, I. in I. Lakatos and A. Musgrave (eds) (1970), p. 92.

[16]. Ruben, D.-H. (1979), ch. III.

[17]. Ibid., pp. 103-104.

[18]. Feyerabend, P. (1975), p. 29.

[19]. Ibid., p. 35.

[20]. Feyerabend, P. (1978), p. 23.

[21]. Newton-Smith, W. H. (1981), p. 127.

[22]. Ibid, p. 130.

[23]. Feyerabend, P. (1975), chs 5,6.

[24]. Ibid., Ch. 11.

[25]. Ibid., Ch. 16.

[26]. Ibid., p. 198.

[27]. Ibid., p. 21.

[28]. Ibid., p. 207.

[29]. Ibid., ch. 17.

[30]. Quine, W. V., (1960), ch. 2.

[31]. Hollis, M. and Lukes, S. in M. Hollis and S. Lukes (eds) (1983), pp. 5-12.

[32]. Barnes, B. and Bloor, D. in M. Hollis and S. Lukes (eds) (1983), pp. 22-25.

[33]. Ibid., pp. 22-25.

[34]. Popper, K. (1977), pp. 387-388.

[35]. see section III.4.

[36]. see section III.4.

[37]. Wittgenstein, L. (1953), sec. 23.

[38]. Krige, J. (1980), p. 142.

[39]. Feyerabend, P. (1978), p. 101.

[40]. Newton-Smith, W. H. (1981), p. 144.

[41]. Feyerabend, P. (1978), p. 100.

[42]. Newton-Smith, W. H. (1981), p. 145.

[43]. Feyerabend, P. (1978), p. 102.

[44]. Newton-Smith, W. H. (1981), p. 145.

[45]. Ibid, p. 145.

[46]. Chalmers, A. F. (1982), p. 142.

[47]. Newton-Smith, W. H. (1981), p. 146.

[48]. Chalmers, A. F. (1982), p. 141.

[49]. Krige. J. (1980), p. 142.

III.6 KNOWLEDGE AND THE ONTOLOGICAL QUESTION.

III.6.1 Outline of scope of discussion.

As the account of the four systems (III level systems, according to the terminology proposed [1]), which constitute the poles of recent epistemological debates indicates, their differentiation roughly speaking, finds expression in the way they interpret or prescribe the scientific enterprise with regard to certain focal points.

These focal points are the distinction of theory and observation, including their relative importance and the pattern of scientific growth. The way scientific method is described (or in certain cases prescribed) depends on the former, while the latter is related to issues such as criteria of demarcation and the status of scientific knowledge [2].

One way of examining the underpinnings of these philosophical systems and the way the above focal points are articulated, is through a discussion of how the issue of reality is conceived in this context.

The issue of reality is fundamental - one could claim with justification that it is central to philosophy, as opposed to philosophy of science. As such, the position regarding reality, within the epistemological systems, could be seen from the standpoint of more general philosophical systems (I level systems [3]). Thus, these epistemological systems are given a certain shade which could enable one to make finer distinctions: e.g. distinctions between the various philosophers espousing inductivism, with reference to scientific reasoning but starting from non identical assumptions at the ontological level. The general systems of philosophy in terms of ontology which philosophers of science encounter are idealism, scepticism and realism. To these pragmatism may be added.

Pragmatism is rather different from the other philosophical systems in two senses:

-firstly, it does not principally deal with ontology in general, i.e. the ontological status of theoretical and observational entities;

-secondly, philosophy of science and education were among the major concerns of some pragmatists, notably Dewey.

Furthermore, of particular interest in relation to the ontological argument is a form of inductivism, i.e. logical positivism. This is due to the clear cut ontological position to which its exponents subscribe and their particular influence in the epistemological debates (Vienna Circle) [4].

Admittedly, from a philosophical standpoint, terms like realism, idealism and pragmatism are very general, despite their widespread (although not always precise) use in educational debates, as evidenced in the paper by Smolicz and Nunan [4].

In the remaining sections of this chapter, an attempt will be made:

-To discuss a number of issues relevant to these terms. These include: the demarcation between these principal philosophical systems, i.e. between realism and idealism including certain of their extreme versions, as well as between "intermediate" (II level) systems, i.e. pragmatism and logical positivism;

-To make explicit their connections with the systems dealing specifically with the philosophical dimensions of scientific knowledge and reasoning.

-In addition, (with regard to pragmatism and logical positivism), the problem of theory and/or method choice and the relevant criteria will be discussed.

In the above, reference to the distinction between the epistemological and ontological levels was made. There is, however, a further necessary distinction. One could distinguish between ontology, in a broad sense, and ontological issues with particular reference to scientific knowledge. Thus, for instance, realism in general could be distinguished from "scientific realism"; the latter dealing exclusively with the status (in ontological terms) of scientific theoretical and observational entities. This is not to say that "scientific realism" differs in philosophical orientation from realism in general. It is rather because scientific realism is of immediate relevance to scientific knowledge, that it is of particular interest in the context of this thesis. By adding scientific realism to pragmatism and logical positivism, the intermediate level (II level systems [5]) of the taxonomy of the philosophical systems under discussion is formed.

III.6.2 Realism and Idealism.

No matter what direction a philosophical enquiry - and especially one concerning the nature of scientific knowledge - may take, and no matter what its scope is, the "problem of being" has to be eventually confronted, at least implicitly [6]. It should be stressed that in this regard, there exists consensus across the spectrum, on the importance of underpinning knowledge claims by ontological considerations. This consensus stretches from both inductivists to relativists (on the epistemological level) and from realists to idealists (on the ontological level). Evidence of this can be found in van Freesen [7], Popper [8], Newton-Smith [9], Hacking [10], Putnam [11], Ruben [12], Althusser [13], Hegel [14].

Accepting this, a series of relevant questions arises. What does one mean by reality? Is there any distinction between reality and existence - if so, what is it? Are there certain things which can be called real? If this is the case, how can one distinguish between truly real and other entities? If so, what are these other entities? Are they images or counterfeits of the real? Or, more concretely, what is it to say, for instance, that an "electron is real"? Finally, is there any sense in addressing such questions? These issues are considered in this section.

Reality and existence, in accordance with the views expressed in this thesis, are two sides of the same coin, sharing certain qualities, but being essentially different. To clarify this, two notions (and the implied dichotomies) will be employed:

-Reality which is the other side of appearance. That is to say whether one accepts the world as it appears or whether one seeks access to the way the world essentially is [15].

-Existence or "being" which is connected with the question of whether or not the constituent parts of reality (in other words the objects on which knowledge is founded) have an existence, independent of thoughts about them [16].

Taking these into account and returning to the question about the meaning of "X is real" (X being an electron or a table, etc.), it could be said that to state such a proposition is in fact to claim that:

1. certain objects are constituent parts of physical reality, and,

2. their existence is independent of the way they are conceived (their appearance).

It should be stressed however that this is not necessarily to say that physical reality is something unalterable, immovable, with which human beings do not interact. To elaborate briefly, Smart [17] and Marx (as argued by Ruben [18]) appear to show the right direction by stressing that our notion of reality is dependant on and formed by our abilities to intervene and change the world.

It thus appears that taking into account this qualification, one can contribute towards solving a tantalising dilemma within recent educational debates: i.e. the diametrically opposed positions which consider knowledge (and therefore school curricula) as either something exterior with which pupils should be acquainted (e.g. Phenix [19], Hirst [20]), or as an arbitrary social construction, without any value outside the social stratum, which is responsible for such an organisation of knowledge (Michael Young et al. [21]).

After having attempted to establish a working terminology, the sort of answers (to the ontological question) given by the above mentioned philosophical systems will now be addressed.

Deciding what is real is a problem which has a long and acrimonious history. This question in its profound simplicity strikes a notoriously difficult issue in the history of philosophy. Roughly speaking one can discern two sorts of answers, each of which has an impeccable record dating back to the arguments posed by the Presocratics and Plato [22]. These two main stances are realism and idealism. Needless to say this distinction is a crude one since each of these philosophical systems has ramified into various, and sometimes overlapping, subschools.

Realists (in a broad philosophical sense, to be distinguished from "scientific realists"), regardless of the particular school to which they belong, argue that "being" (object) is dominant and encompasses consciousness within itself, whilst for idealists, consciousness is dominant and encompasses "being" within itself [23]. In other words, idealism implies that no object exists independent of human thoughts about it, while realism maintains that the existence of the constituent parts of physical reality is independent of thoughts about them [24].

Finally, as stated above, it is necessary to consider whether these questions should be addressed at all. In this regard, there is no way of producing a conclusive answer. On the one hand, scepticism contests the meaningfulness of such a query. According to this philosophical system, knowledge of how things really are may be sought, but cannot be found. The reason lies in the unreliability of our senses. One has only to look (the sceptical argument goes on), at the way experts contradict one another. So, there is no way of producing a "conclusive" answer [25]. This stance, however, despite its appearance as "neutral", inevitably leads to relativism which is more akin to idealism than to realism.

This rough, but fundamental three-fold distinction between idealism, realism and scepticism, does little to help one contrast directly and in detail the implications of the postulates of each of these systems, either in terms of knowledge claims or methodological issues. Being so general, it begs the following questions:

-when one speaks of mind dependence, does one include minds other than one's own (Q1)?

-does the mind-dependence of objects mean that one can meaningfully investigate only the relations of objects and relevant phenomena or is one able to query the objects themselves (Q2)?

The answers to such questions, which constitute the basic starting points of the different philosophical systems will be discussed briefly. However, before entering this discussion, an essential point must be restated, namely that the position adopted in this thesis is one where the choice (implicit or explicit, conscious or unconscious) made by any individual (or groups of individuals), in so far as his stance on the ontological level is concerned, is ultimately not a matter of "proof" in its formal sense. Attempts to defend a certain ontological position are in the final analysis a matter of value judgement and one can neither invoke common-sense (very often misleading and inconclusive, formally), nor pure "reason" (vicious circularity, since these issues bear upon the forms of reasoning), in defense of one s choice. This leaves then, as a way out, only the identification of the consequences of a certain ontological position regarding a variety of aspects. These range from the scientific (e.g. existence of electrons) to the social, the religious, the ethical or the aesthetic, when defending or attacking a certain ontological stance. In other words 'praxis" is ultimately the criterion of choice for a certain ontological stance. Obviously a more elaborate analysis of this point remains, despite its crucial character, well beyond the scope of this thesis. It should be noted however, that this is far from disputing the legitimacy of ontological queries. On the contrary, as already stated, the kind of ontological beliefs one holds not only underpin one's thought, but render it with regard to other levels (e.g. epistemological), both meaningful and coherent.

Returning to the above mentioned questions, the first (Q1), entails the distinction between idealism in general and its more extreme variation, namely solipsism. Solipsism, roughly speaking, holds that one can be sure only of one's own mind Or, as O'Hear [26] put it, "the theory that there is nothing in the world other than myself and my ideas". This is a position occupying the precarious privilege of being, in a way, the extreme consequence and at the same time, the least defensible version of idealism (if one wants to take idealism to its "logical" conclusions). It is claimed that solipsism is an extreme/terminate version of idealism because once one concedes (following for instance Locke) that the immediate objects of sensory experience are mind dependent (ideas. impressions, etc.), the extent to which one can forcibly argue for the existence of another conciousness (or mind) external to one s own is indeed highly questionable. In this sense other minds or consciousness are in fact constituent parts of the world external to ourselves and therefore their existence is questionable, as are other objects (e.g. chairs). Clearly, this is the almost "pathological" consequence of Cartesianism.

If however, solipsism is "logically" a strong version of idealism, it is also on this view thoroughly indefensible. Oliver [27] argues that one can attack solipsism from two perspectives: namely the psychological and philosophical.

Psychologically, solipsism entails and is consequently characterised by withdrawal - principally withdrawal into a private world. How then does one argue for solipsism? What becomes of reason in the world of the solipsist? For, such a stance not only questions the legitimacy of thinking about other's minds (psychology for instance is impossible within this framework, as Ogborn [28] remarks), but even prohibits any intelligible communication.

Philosophically speaking, solipsism is in a way paradoxical: adopting the privacy postulate and taking for granted the respect for "reason" (otherwise "thinking" is impossible), is probably an attempt to deal effectively with the fact of error by bypassing it. This attempt however, is of considerable futility. Firstly, to bypass something is not to tackle it. Secondly and more fundamentally, O'Hear [29] argues that "coping with my own experiences, [means that] my solipsism will have to rely on a set of terms and beliefs which entail the falsity of solipsism".

The second question (Q2) refers to the distinction between philosophical idealism and phenomenalism. Phenomenalism differs from the former because it deals more explicitly with issues concerning the relation of scientific reasoning and ontology. As Harre [30] put it, phenomenalism, in its extreme form, holds that only propositions about observed phenomena have the status of genuine knowledge. Therefore, on the basis of this theory science should concern itself only with the identification, classification and codification of phenomena. The term "phenomena" indicates here what can be analysed from what is perceived. The association here with empiricism is obvious.

To illustrate their differences as well as similarities, it is possible to draw on the one hand on Hegelianism, and on the other on the philosophy of Berkeley and Mach (phenomenalism). For Hegel [31], an idealist himself, "...self-conciousness is ... certain its self is reality, certain that all concrete actuality is nothing else but it". Berkeley, a phenomenalist [32], wrote "It is plain philosophers amuse themselves in vain, when they inquire for any natural efficient cause distinct from a mind or spirit" and "...by a diligent observation of the phenomena, we may discover the general laws of nature, and from them deduce the other phenomena, I do not say demonstrate" [33]. Finally, Mach declared that "...in the investigation of nature, we have to deal only with knowledge of the connection of appearances with one another" [34].

It seems then that a final remark is in order: what has been attempted is to demarcate roughly between realism on the one hand, and scepticism and idealism - including certain philosophical systems considered akin to the latter - on the other, so as to put in perspective the subsequent considerations regarding "scientific" realism. For this reason the discussion has been confined within certain limits and other philosophical systems, referring to distinctions such as transcendental vs. materialistic realism and its versions [35] (obviously of great importance to ontology), have not been included.

III.6.3 Ontology in the context of scientific knowledge.

Of particular interest in the context of this thesis is scientific realism, or more precisely realism with regard to the ontological issues in relation to scientific knowledge. As Hacking [36] puts it "scientific realism says that the entities, states and processes described by correct scientific theories really do exist". In other words, protons or electrons are as real as tables or chairs (assuming of course that one does accept the existence of such things as tables or chairs).

In a more abstract vein, Harre tries to encapsulate scientific realism schematically by way of the following three principles:

"1. Some theoretical terms can be used to make reference (verbal) to hypothetical entities.

2. Some hypothetical entities are candidates for existence (i.e. some could be real things, qualities, and processes in the world).

3. Some candidates for existence, for reality, are demonstrable, i.e. can be indicated by some sort of gesture of pointing in the appropriate conditions" [37].

The above example highlights two important points. Firstly, the belief that idealism is indefensible in philosophy of science even if it cannot be proved "rationally" wrong. Secondly, it shows that while positions denying the existence of directly observable things have been abandoned, this is far from true in the case of non-observable entities. The question concerning the distinction between theory and observation and consequently of entities whose existence is entailed by either of them is once again at stake.

Because the ontological beliefs referring to the various entities are interwoven with the way the difference between theory and observation/experiments is understood, the latter is regarded in the present analysis as the bridge which facilitates the move from the ontological to the more "technical" epistemological level.

From what has been said about scientific realism, it is obvious that in its context the distinction between theory and observation is recognised in a technical and very limited sense (terms like concrete and abstract are much more appropriate) on the one hand, but on the other hand realists hold that at the ontological level this distinction cannot be drawn. Thus, the assertion that observations are theory-loaded takes on a completely different meaning for the realist than, for example, the idealist. One can cast further light on this by taking into account that for the former, entities do exist independently of human thoughts and that if one wishes to demarcate between theory and observation this is possible in a very technical sense, while for an idealist neither of the entities exists outside human minds.

A consequence of the realist position is that it implies a notion of knowledge in such a way that true theories can be considered to describe correctly some aspect of the real world (correspondence or reflection theory of knowledge) [see note (a) on III.6].

What characterises and diversifies the various sub-schools within the camp of scientific realism is the particular version of the correspondence theory employed. Moreover it should be noted that this notion of correspondence theory is employed by philosophers belonging to logical positivism which is an "anti-realist" system [41].

The correspondence theory of knowledge is a consequence of realism because realists set out to defend the idea that truth depends on the way things are in the world (existence) and not on the way one looks at things or conceptualises reality (the appearance - idealistic position), or on what satisfies one in some way or another (the usefulness - pragmatism) [42].

A final remark about the correspondence theory of knowledge (which from a "scholastic" standpoint is distinct from the correspondence theory of truth, but in the view taken here does not amount to any substantial difference) refers to the notion of approximation as opposed to exact depiction. Such a move enables one to overcome some objections to the application of the correspondence theory to science. For instance, one could say that Newton's theory is a better approximation than Galileo's even though both are less accurate than the mechanics of the theory of relativity. In this respect, the work of Tarski [43], who defines truth recursively through the distinction between "object" language and "meta-language", is quite crucial. This is not to say however, that a robust version of this theory, which takes the ideal end-point of some branch of science as the "absolute truth", is defensible. As Chalmers [44] has remarked "science is a social product, and if it were ever to reach its end-point, so conceived would abruptly change from being a human, social product to being something that in one strong sense is not a human product at all". Further elaboration of this point lies beyond the scope of this thesis, although it should be said that the position adopted here is one wherein the process of science approximates reality closer and closer, but never quite reaches an end-point.

Apart from idealism, two other responses have been developed with regard to scientific realism: pragmatism and positivism (and especially its more recent version, logical positivism) [45].

Pragmatism has no quarrel with common sense notions. For instance, chairs and electrons are both real in so far as one never comes to doubt their value. For Peirce who is the father of the term pragmatism "...the real then, is that which, sooner or later, information and reasoning should finally result in and which is therefore independent of the vagaries of me and you" [46]. This sounds very close to the position of realism. How therefore do they differ? In the interpretation adopted here, the difference between pragmatism (or at least, this branch of pragmatism, as distinct from instrumentalism) and realism lies in how the criteria of truth are defined within them [47].

For realists, truth to some degree corresponds with physical reality. Crudely speaking reality itself is the definition of truth, practice being the criterion for truth. On the other hand, pragmatists are in this respect, potentially the heirs of the Kantian legacy. They take for granted that process and contingent progress are the essential characteristics of the nature of human knowledge. Of particular interest is Hacking's [48] remark that Peirce tried to replace truth by method, being in this respect the precursor of Popper. Thus, for him, method is a substitute for the idea that truth corresponds to a mind independent reality. Truth then, is whatever the community of researchers, who pursue a certain end and in a certain way, is delivering in the end. Thus, for pragmatists of this type (Peirce, Putnam [49]) practice (and usefulness) is in the final analysis the definition of truth.

The other influential type of pragmatism which became known as instrumentalism, is far more explicit. Dewey had no interest (in the long run) in how canons of rationality are developed - rationality is extrinsic: it is whatever scientists agree on [50] (the influence of instrumentalism on Kuhn is quite obvious, in this respect). Furthermore, theories have no truth in themselves - they should rather be understood as instruments, as opposed to literary assertions that intervene when scientists try to follow their queries. Thus, instrumentalism involves a sharp distinction between theory and observation. In this respect, this branch of pragmatism is much further from realism than its first version. Indeed, one could say that the latter is much closer to the second response to realism, i.e. positivism.

Positivists set out to show that all speculations about existence are cognitively meaningless [51] - some of Wittgenstein's remarks in the "Tractatus" [52] would appear to support this position. For instance, sentences containing terms like being, substance, noumena are not analysable into sentences about anything a human being could possibly experience. In principle, their target is any metaphysical speculation and it is interesting to note that they use the term "metaphysics" to denote any ontological query, whilst in reality they end up with another ontological speculation, not very different from the common sense of an empiricist. For them, there are no electrons, nor any other unobservable entities or, as Hacking puts it "in a less dogmatic mood they say that we have no good reason to suppose that such a thing as an electron exists; nor have we any expectation of showing that it does exist" [53]. Unless we are able to observe something, this cannot be known to be real. This, it would appear to be a good reason for establishing a connection between them and the sceptic tradition, which Hume best represents.

In trying to demarcate between positivists and pragmatists, one should point out that pragmatism shares the Kantian-Hegelian doctrine, which puts all its faith into the process of knowledge [54]. For instrumentalists, terms that seemingly denote invisible entities do not function as referential terms [55]. Positivists, on the other hand, hold that theoretical expressions should be believed but not be taken literally [56]. This should be seen in conjunction with one of the basic tenets of logical positivism, namely the strong assertion that the distinction between theory (theoretical entities) and observation (observational entities) is quite fundamental [57]. This determines their position in so far as the ontological status of entities postulated by theoretical statements is concerned. Since theoretical statements should not be taken literally, obviously entities (the existence of which is postulated by these statements), are not real.

Of considerable interest in the context of this thesis, is the issue of what, within logical positivism and pragmatism (instrumentalism included) count as adequate criteria for theory choice, given the position which this issue occupies regarding the four previously discussed epistemological systems.

For pragmatists - either its mainstream version (e.g. Peirce), or the instrumentalist version (e.g. Dewey) - "descriptions of the observable world will be true or false according to whether or not they correctly describe it. However, the theoretical concepts and constructs, that are designed to give us instrumental control of the observable world, will not be judged in terms of truth or falsity but rather in terms of their usefulness as instruments" [58]. What follows according to pragmatists is that "usefulness" is the criterion for theory choice. As Laudan [59] argues, theory T1 is to be preferred to theory T2 when T1 solves more problems than T2. We ought not to worry whether T1 is closer to the truth than T2. A position like this however, raises some interesting sociological questions of the type "useful for whom?", particularly if one adopts a sociological theory belonging to the "conflict" family.

For the exponents of logical positivism, the issue of theory choice is a matter of conforming to methodological principles. It could be added that for the mainstream of this system, the cornerstones of these principles are inductive reasoning and verification [60] (as opposed for instance, to deductive reasoning and falsification, which roughly epitomise the hypothetico-deductive position [61]).

In the following table, an attempt is made to summarise the interpretation of the main philosophical systems at both the ontological and the epistemological level.

		Realism	Idealism	Scepticism	
I Level Systems	Ontological Question	Physical Reality "as it is"; independent of human thoughts	Physical Reality "as it appears"; dependent on human thoughts	Meaningless Question	
		Sc. Realism	Log. Positivism	Pragmatism	
II Level Systems	theoretical entities	Real	No real existence	Instrumental	
	observational entities	Real	Real	Real	
		Inductivism	Hyp.- Deductivism	Contextualism	Relativism
III Level Systems	theory-observation distinction	significant (observation privileged)	exists (theory privileged)	no distinction	no distinction
	Status of scientific Knowledge	special	special	special ------- no difference (depending on version of contextualism)	no difference

TABLE T3.1: Philosophical-epistemological systems.

III.6.4 Some tentantive connections: Linking the epistemological and ontological levels.

In addition to the representation of various positions their connections need to be made explicit. The focus will be on the potential contradictions that arise when two incompatible positions are held: these being on the ontological and epistemological levels, respectively.

What the analysis thus far has indicated (as summarised in table T3.1) is that the various philosophical systems belonging to both the ontological and the epistemological levels could be juxtaposed by using the axes defined by the following distinctions:

1. theory-observation distinction;

2. status of scientific knowledge (for the epistemological level);

3. the distinction between appearance and reality (first level ontological systems);

4. the ontological status of entities entailed respectively by theoretical and observational statements (second level ontological systems).

As table T3.1 indicates inductivism postulates a very strong distinction between theory and observation; observation being privileged vis-a-vis theory in epistemological and semantic terms which ultimately are based on a different ontological status. This view seems to be incompatible with the realist view which does not see any significant difference between theory and observation in ontological terms, while recognising that observation is a good starting point. On the other hand, it is compatible with the two other first level ontological systems, namely idealism and scepticism. The reason for arguing in this way is that inductivism, based on the strong distinction between theory and observation, leads through its emphasis on observation to a reinforcement of the view that science should restrict itself to appearance (idealism). Alternatively, by recognising the imperfect nature of the inductive schema of reasoning (when defending it by introducing probability) it may lead to the admission that knowledge of the world "as it is" is impossible and therefore that ontological claims make no sense (scepticism).

Regarding the second-level ontological systems, inductivism seems to be incompatible with scientific realism, which attributes the same ontological status to both theoretical and observational entities and to pragmatism (or instrumentalism), which plays down this distinction. Logical positivism however, is in accordance with inductivism - (in fact it is inductivism's extreme version if one follows the sort of logic implied by this position).

The second of the epistemological systems, namely hypothetico-deductivism, seems to be compatible with both realism and idealism but not with scepticism. The exemplification of this argument can be found in the systems proposed by Popper and Lakatos respectively. The former subscribes to realism while the latter leans towards idealism (Hegelian version). It should be noted that due to the fact that objectivity is an essential characteristic of the scientific enterprise, hypothetico-deductivism becomes incompatible with scepticism. In so far as the second-level ontological systems are concerned, the first version of hypothetico-deductivism (Popperian) is compatible with scientific realism, while it differs from pragmatism regarding the ontological premises and from logical positivism regarding both the ontological premises and technical aspects (i.e. falsification versus verification; deductive versus inductive schema of reasoning). Its second version (Lakatosian) is more akin to pragmatism (but not identical), given the faith both systems put in the process of knowledge (Hegelian heritage).

The third of the above mentioned epistemological systems, namely, contextualism, is more difficult to locate in terms of the above grid of distinctions. In both its versions (Kuhn being an "embryonic rationalist" or a "temperate non-rationalist"), a connection could be established with pragmatism, particularly with regard to the aspect of the conception of truth and theory choice within these systems. Furthermore, this contention appears to gain force when seen in the context of the triangular framework of the second-level ontological systems. In other words, when contrasting contextualism with either scientific realism or logical positivism, its connections with pragmatism become clearer. On the primary ontological level however, it could be said that contextualism and particularly its second version is geared towards scepticism rather than towards realism or idealism. A note of caution is in order here: as argued in an earlier chapter, contextualism is open to a rather wide range of interpretations. Thus, the above mentioned incompatibilities should be seen as more tenuous in this case than in the case of the other epistemological systems.

Finally, the essence of relativism should be seen to lie in its tenets concerning the status of scientific knowledge as opposed to within the theory-observation distinction. For this reason as in the case of contextualism, contingent connections with philosophical systems at levels other than the epistemological are not as direct. Given, however, the difficulty in establishing criteria for a comparative evaluation of the different kinds of knowledge within relativism, one inevitably drifts towards the same sort of conclusions as with scepticism. Taking this into account a connection between these two systems could be established. Again, judging from the standpoint of the potential consequences of relativism and realism (including scientific realism) one could discern the resulting tensions. Needless to say, relativism is incompatible with logical positivism. In so far as the relationship between pragmatism and relativism is concerned, there seems to exist a slight tension, given the optimistic outlook inherent in pragmatism regarding scientific knowledge, as opposed to the pessimistic complexities found within relativism.

The diagram below attempts to portray the above representation of the connections between the various philosophical systems.

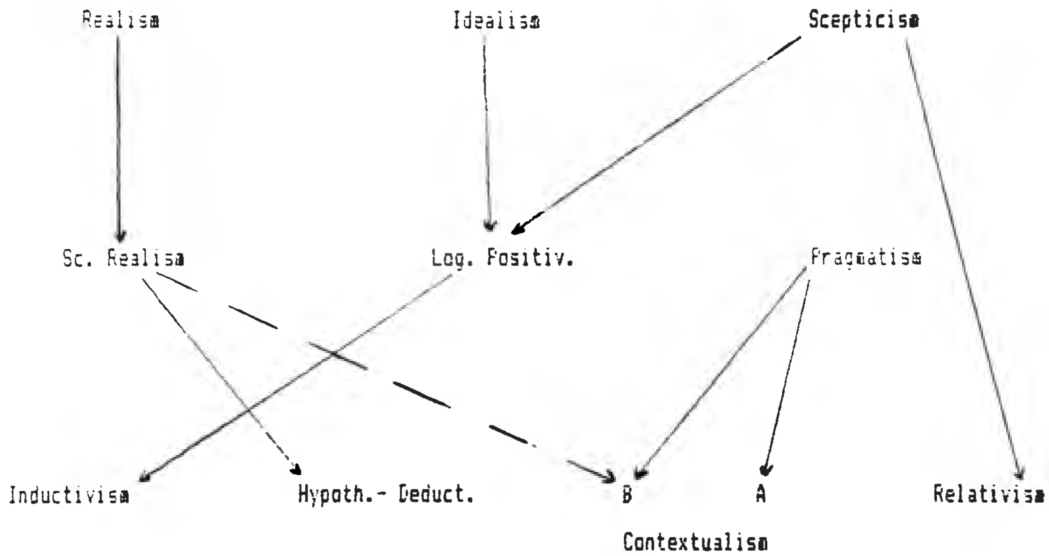


DIAGRAM D3.2: A tentative linkage between systems at the philosophical and epistemological levels.

III.6.5 Reflecting an image.

As in the previous cases, the attempt here is not to select a fully comprehensive set of statements which depicts each of the above discussed systems; it is rather an attempt to present certain statements so as to permit a rough distinction between what is termed the "first" and "second" level philosophical systems. This distinction is based exclusively on the most basic tenets of each system.

These statements are as follow:

I. First level systems.

A. For realism.

The world of nature exists independently of human thoughts.

B. For idealism.

No objects exist independently of thought about them.

C. For scepticism.

There is no sense in asking whether observable things (like mountains) or unobservable entities (like energy) exist or not.

II. Second level systems.

A. For scientific realism.

1. The world of nature exists independently of human thoughts.
2. Genes, photons or chemical bonds exist, as do rabbits, radios or chairs.

B. For pragmatism.

1. Only observable things e.g. rabbits, radios or chairs, exist.
2. In general the better of two competing theories is the one which gives the more useful results.

C. For logical positivism.

1. Only observable things e.g. rabbits, radios or chairs, exist.
2. In general the better of two competing theories is the one which is nearer to the "truth".
3. To be sure of approaching nearer to the "truth", one should follow the appropriate scientific method.

NOTES ON III.6

*(a). Many have argued for this point. For reference to representives of all the tendencies of realism (including scientific realism), see Smart [38], McMullin [39], Ruben [40].

BIBLIOGRAPHICAL NOTES.

[1]. section III.1.

[2]. sections III.2, III.3, III.4 and III.5.

[3]. section III.1.

[4]. Hacking, I. (1983), ch. 9.

[5]. section III.1.

[6]. Smolicz, J. J. and Nunan, E. E. (1975), p. 101.

[7]. Fraasen, van B. C. (1980), pp. 16-19.

[8]. Popper, K. (1983). The whole book is indeed an attempt to justify this point.

[9]. Newton-Smith, W. H. (1981), ch. XI.

[10]. Hacking, I. (1983), ch. 16.

[11]. Putman. H. (1984), pp. 140-153.

[12]. Ruben, D.-H. (1979), Introduction and ch. IV.

[13]. Althusser, L. (1970). Roughly speaking, in this book Althusser discussed the issue of objectivity which he defended. This position presupposes a realistic interpretation.

[14]. Hegel, G. W. F. trans. by W. H. Johnston and L. G. Struthers (1966), p. 57.

[15]. Harre, R. (1972). ch. 3.

[16]. Hacking, I. (1983), pp. 92-93.

[17]. Smart, J. J. C. (1963), pp. 120-122.

[18]. Ruben. D.-H. (1979), pp. 112-113.

[19]. Phenix, F. H. (1964).

[20]. Hirst, P. H. (1965).

[21]. Young, M. F. D. (1973).

[22]. Turnbull, R. G. (1983).

[23]. Papanoutsos, E. P. (1968), p. 6.

[24]. Hacking, I. (1983), p. 96; the same point is shared by almost everybody.

[25]. O' Hear, A. (1985), p. 111-119.

[26]. Ibid., p. 29.

[27]. Oliver, W. D. (1970), pp. 30-34.

[28]. Ogborn, J. (1985), pp. 2-3.

[29]. O' Hear, A. (1985), p. 30.

[30]. Harre, R. (1972), p. 94.

[31]. Hegel, G. W. F. trans. by J. B. Baillie (1966), p. 273.

[32]. Harre, R. (1972). pp. 70-72.

[33]. Berkeley, G. ed. by A. A. Luce and T. E. Jessop (1951), section cvii.

[34]. Mach, E. tran. by P. E. B. Jourdain (1911), p. 49.

[35]. Hacking, I. (1983), ch. 7.

[36]. Ibid., p. 21.

[37]. Harre, R. (1972), p. 91.

[38]. Smart, J. J. C. (1968), pp. 77-78.

[39]. McMullin, E. (1984), pp. 23-25.

[40]. Ruben, D.-H. (1979), ch. III.

[41]. Hacking, I. (1983), ch. 10.

[42]. O' Hear, A. (1985), p. 91.

[43]. Tarski, A. (1969).

[44]. Chalmers, A. F. (1982), P. 157.

[45]. Hacking, I. (1983), ch. 10.

[46]. Peirce, S. in J. Buchler (ed.) "The Philosophy of Peirce" p. 247, cited by I. Hacking (1983), p. 58.

[47]. Geymonat, L. (1973), pp. 178-194.

[48]. Hacking, I. (1983), p. 59.

[49]. Putnam, H. (1982).

[50]. Hacking, I. (1983), p. 62.

[51]. Asby, R. W. (1964), p. 494.

[52]. Wittgenstein, L. (1922).

[53]. Hacking, I. (1983), p. 41.

[54]. Ibid., p. 63.

[55]. Ibid., p. 63.

[56]. Ibid., p. 50.

[57]. Ibid., p. 42.

[58]. Chalmers, A. F. (1982), P. 147.

[59]. Laudan, L. (1981), p. 144.

[60]. Hacking, I. (1983), p. 41.

[61]. ch. III.3.

IV. SYSTEMIC NETWORK ANALYSIS.

This chapter deals briefly with the technique of systemic network analysis (used as a basis for the development of the research instrument). In addition the particular networks employed here are presented.

More specifically, the points raised are as follows:

1. The origin and the historical background of the technique.
2. An exposition of the technique including the basic ideas and notation.
3. The systemic network developed for the purposes of this thesis, followed by an attempt to link it with the analysis of the relevant issues made in chs. II and III.

IV.1 The origin and historical background.

Networks were originally developed by systemic linguists (e.g. Halliday [1]) to formalise their functional approach to grammar. They arose as a means for expressing the idea, put forward by Saussure [2] and later by Firth [3], that meaning in language can be described in terms of choice. That is, a phrase has a particular meaning, not so much because of some intrinsic attributes of the words involved, but because of its opposition to the possible, but nevertheless, not chosen phraseology.

The use of the technique of systemic network analysis in the context of educational research was conceived by Bliss and Ogborn [4] as a means leading to the formation of a scheme of descriptive categories for handling qualitative data. Bernstein [5] and Ogborn [6] proposed the use of this technique for the description and coding of data of that kind. Furthermore, as evidenced by Bliss, Monk and Ogborn [7] this technique has been used by a number of researchers to provide the basis for a subsequent analysis of qualitative data.

IV.2 An exposition of systemic network analysis technique.

Systemic network analysis can usefully be regarded as an extension of categorising. Thus, a network can be seen as a map of the set of categories one has chosen to use, which shows how they relate to one another [8].

What is said essentially means, that "to categorise is to draw distinctions and to name them recognising that distinctions may need to be drawn along several independent dimensions and that any distinction may need to be further divided into subsidiary divisions" [9]. Networks offer a uniform notation to express such schemes at any required level of complexity and a terminology intended to clarify and assist communication of the issues involved.

The purely notational aspects of networks are simple. Networks can be constructed using just a few elementary notations: two indicating kinds of choice or selection (bar, bracket), one indicating constraints or conditions on choice (inverse bracket), and one indicating the possibility of repeated choice (symbol of recursion) [10].

Bar is taken to indicate mutually exclusive categories at one level; bracket co-occuring categories (that is simultaneous categorisations on two or more aspects); inverse bracket a conditional link (which is used to draw together certain meaningful combinations of distinctions for developing the network further in selected areas); recursion symbol which acts as an optional choice to repeat the function indicated by a bar or bracket.

To exemplify this notation a description of certain aspects of the structure of Greek education at the secondary level follows:

```
             -------->Gymnasia
             :
             :
             :
             :
Structure--  :
             :
             :                           ------>General (Academic)
             :                           :
             :                           :
             --------> Lycea ---------:---->Technical-Vocational
                                         :
                                         :
                                         ------>Multilateral

             -------->State
             :
             :
             :
    Sector-- :
             :
             :
             :
             -------->Private
```

In addition to the above notation there are two other formal components which could be seen as a driving force in network construction: delicacy and rank.

Categories (and subcategories) can have their own subcategories. Correspondingly, terms on a bar can lead to further systems so generating a tree-like structure as illustrated in the above network. Thus, in a finished network as one passes down any branch of the tree, it is usual to find that the right hand distinctions become finer than the left hand ones. The network is more "delicate" as it develops from left to right [11].

In this context, rank is used as a technical term for changing the level of discussion. For instance, consider the above example of a network concerning the organisational structure of Greek secondary schools. Referring to this example, will one choose to construct a network to make distinctions such as "hierarchical", which distinguish different kinds of total structure, or will one choose to describe smaller elements of that structure such as "department" together perhaps with their relationship to one another? In the first case, the network categories make distinctions about the whole; in the second such differences would emerge as different patterns in describing the arrangements of the parts [12]. The second case involves change of rank.

It should be stressed however, that the application of this technique in educational research concerns mainly qualitative data analysis. In the context of this thesis, the sequence is in a way reversed. Systemic network analysis is used in an a-priori fashion that is, in the course of conceptual organisation aiming at the construction of the instrument. An attempt to justify this choice is made in the following chapter V.

IV.3 The systemic network used in the construction of the research instrument.

In this section, the network, which was constructed to lay the ground for the development of the research instrument, is presented. The various parts of the network are based on the analysis of the relevant issues, specifically chapter III for the (philosophical -epistemological component) and chapter II (for the curricular and pedagogical components).

Besides the presentation of the network, an attempt is made to provide links between the development of the network and the background analysis. Thus, following the presentation of each part of the network a table is given in which both the relevant distinctions as well as the sections of the thesis where these distinctions are discussed, are shown.

A. Philosophical-epistemological component.

The areas ("themes") around which the analysis of the philosophical-epistemological component is conducted are five, as indicated in ch. III, namely scientific methodology, criteria of demarcation, patterns of scientific change, the status of scientific knowledge and finally the issue of reality.

1. Scientific Methodology.

```
                                                  ----->Inductivism  1. Observation preceeds Theory.
                                                  |                  2. Verification.
                      ----->One scientific method-----|
                      |                           |
                      |                           ----->Hyp.-Deductivism  1. Theory preceeds Observation.
                      |                                                   2. Falsification.
Scientific methodology---|
                      |                                          --->Version B ('intrinsic' criteria).
                      |                           --->Contextualism--|
                      |                           |              --->Version A (a matter of consensus).
                      ---->Many scientific methods----|
                                                  |
                                                  --->Relativism.
```

This part of the network primarily distinguishes methodological views by their attachment to a single "correct" scientific methodology, or to a position allowing variety in method to be proper. The first covers both inductivism and hypothetico-deductivism; the second includes two versions of contextualism, as well as relativism.

	Relevant distinction/topic.	Discussed in section.	Systems.	Argued outcome.
1.	Methodological unity-diversity.	III.2.1	Inductivism.	Methodological unity.
		III.3.1 and III.3.3	Hyp.-Deductivism.	Methodological unity.
		III.4.1 and III.4.3	Contextualism B.	Methodological diversity.
		III.4.1 and III.4.3	Contextualism A.	Methodological diversity.
		III.5.1	Relativism	Methodological diversity.
2.	Inductive-Deductive schema.	III.2.1	Inductivism.	Inductive reasoning. Verification.
		III.3.1 and III.3.3	Hyp.-Deductivism.	Deductive reasoning. Falsification.
3.	Acceptance-rejection of rational rules for the choice of method.	III.4.1 and III.4.3	Contextualism B.	Acceptance.
		III.4.1 and III.4.3	Contextualism A.	Acceptance.
		III.5.1	Relativism.	Rejection.
4.	Basis for such criteria.	III.4.1 and III.4.3	Contextualism B.	Intrinsic criteria.
		III.4.1 and III.4.3	Contextualism A.	Consensus of sc. community.

T A B L E T4.1: References for the theme of "scientific methodology".

2. Criteria of demarcation.

```
                                                   ----->'Truth' (Inductivism, Hyp.-Deductivism).
                                                   |
                          ----->Rational criteria -------|---->'Usefulness' (Pragmatism).
                          |                        |
                          |                        ----->'Consensus' (Contextualism B).
Criteria of demarcation--|
                          |                        --->'Internal  rules (Contextualism A).
                          |                        |
                          ----->Rational criteria -------|
                                cannot be found    |
                                                   --->An issue of values (Relativism).
```

Here, the main distinction is between two fundamentally different views of the possibility of demarcating science from non-science (likewise, demarcating between competing scientific theories). The first, which takes such a demarcation to be possible on rational grounds, nevertheless includes very different alternative ways of doing so - that science is "true", or "useful", or a matter of informed agreement. On the second branch, which rejects a "rational" basis, the ramification distinguishes those who understand such an exercise on the basis of "internal" criteria from relativists (value judgement).

	Relevant distinction/topic.	Discussed in section.	Systems.	Argued outcome.
1.	Acceptance-rejection of "rational" criteria for choice of sc. theories.	III.2.1 and III.2.4	Inductivism.	Acceptance.
		III.3.1 and III.3.3	Hyp.-Deductivism.	Acceptance.
		III.4.1 and III.4.3	Contextualism B.	Acceptance.
		III.4.1 and III.4.3	Contextualism A.	Rejection.
		III.5.1	Relativism.	Rejection.
2.	Basis of criteria for sc. theory choice-if accepted.	III.2.1 and III.2.4	Inductivism	Proper method-"truth".
		III.3.1 and III.3.3	Hyp.-Deductivism.	Proper method-"truth".
		III.6.3	Pragmatism.	"Usefulness"
		III.4.1 and III.4.3	Contextualism B.	Consensus of sc. community.
3.	Basis for choice-if "rational" criteria are rejected.	III.4.1 and III.4.3	Contextualism A.	"Internal" rules.
		III.5.1	Relativism.	Value judgement.

T A B L E T4.2: References for the theme of "criteria of demarcation".

3. Pattern(s) of scientific change.

```
                                         ----->Accumulation of facts. (Inductivism).
                                         |
              ----->Growth (compatible).------|
              |                          |
              |                          ----->Succession of theories. (Hyp.-Deductivism).
              |
Pattern of sc. change----|----->Periods of compatibility and--------->Development (Contextualism B).
              |         periods of incompatibility.
              |                          ---->Development (Contextualism A).
              |                          |
              ----->Change (incompatible) -----|
                                         |
                                         ---->No pattern (Relativism).
```

With regard to the views concerning the pattern(s) of scientific change, one is faced with a gradual shift instead of radically different positions as in the case of the previous two themes. This is not to say however, that the extreme points, i.e. growth of science viewed as an accumulation of observations (facts) and considering changes in science as incompatible and having no discernible pattern, are not fundamentally different. Nor is it to say that the difference between seeing scientific growth from an inductivist perspective and interpreting this process as a succession of theories lacks significance.

	Relevant distinction/topic.	Discussed in section.	Systems.	Argued outcome.
1.	Pattern of scientific change (compatible-incompatible).	III.2.1 and III.2.4	Inductivism.	Compatible.
		III.3.1 and III.3.3	Hyp.-Deductivism	Compatible.
		III.4.1 and III.4.3	Contextualism B.	*
		III.4.1 and III.4.3	Contextualism A.	Incompatible.
		III.5.1	Relativism.	Incompatible.
	*The position on this issue of the second version of Contextualism entails a succession of periods of compatibility and incompatibility. On the whole however, science is thought to grow.			
2.	Mechanism of growth -if compatible.	III.2.1 and III.2.4	Inductivism.	Accumulation of facts.
		III.3.1 and III.3.3	Hyp.-Deductivism.	Succession of theories.
3.	Characteristic of sc. change -if incompatible.	III.4.1 and III.4.3	Contextualism A.	Sc. development.
		III.5.1	Relativism.	No definite pattern.

T A B L E T4.3: References for the theme of "pattern(s) of scientific change".

4. Status of sc. knowledge.

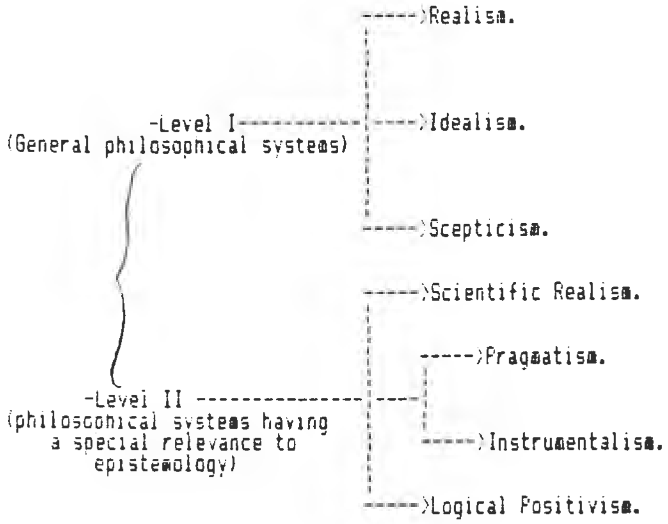
```
                                                       'Objective
                                                 ----->account of nature'.
                                                 |
                       ----->Special status  ----------|----->'Usefulness' (Pragmatism).
                       |                         |
                       |                         ----->'Systematic pattern of thought'.
Status of sc. knowledge--|
                       |
                       |
                       ----->Not unique (an ideology among others - Relativism).
```

The main distinction as far as the status of scientific knowledge is concerned, is between those systems which recognise scientific knowledge as in some way privileged and those which do not attach any particular value to science. This analysis has similarities with that in terms of criteria of demarcation. What differentiates these conceptual maps is that they operate on distinct levels: i.e. arguments belonging to systems of thought of the latter theme constitute the basis for the stances expressed in the former theme (status of scientific knowledge). As a consequence of this, the justifications given by non-relativist systems cover essentially the same ground as in the case of the basis for criteria for demarcation.

	Relevant distinction/topic.	Discussed in section.	Systems.	Argued outcome.
1.	Status of sc. knowledge.	III.2.4	Indictivism.	Special.
		III.3.1 and III.3.3	Hyp.-Deductivism.	Special.
		III.6.3	Pragmatism.	Special.
		III.4.1 and III.4.3	Contextualism B.	Special.
		III.4.1 and III.4.3	Contextualism A.	Not unique.
		III.5.1	Relativism.	Not unique.
2.	Justification-if special.	III.2.4	Inductivism.	"Objective account of nature".
		III.3.3	Hyp.-Deductivism.	"Usefulness".
		III.6.3	Pragmatism.	Systematic pattern of thought.
		III.4.1 and III.4.3	Contextualism B.	

T A B L E T4.4: References for the theme of "status of sc. knowledge".

5. Ontological question.



The distinction between level I and II philosophical systems (defined in section III.1) should be recalled at this point. In level I (general philosophical systems) the network distinguishes three main philosophical systems. At level II (general philosophical systems especially relevant to epistemology) four systems are discerned (pragmatism and instrumentalism taken to be close to one another). A fuller account is given in section III.6.3, summarised by table T3.1.

As was argued in section III.6.4 (see also diagram D3.2) the articulation between these two levels is not necessarily simple. Thus, although realism (level I) fits with scientific realism (level II), pragmatism (and instrumentalism) can be better understood in terms of scepticism (level I), while logical positivism appears to be consistent with either idealism or scepticism (level I).

B. Curricular component.

As one could expect, debates in the area of curricular design and development are more pragmatic (pragmatic in a common as opposed to a philosophical sense) in character. Accordingly, there is a tendency, regarding the relevant parts of the network to reflect this pragmatic character. The subject matter of the curricular component includes two strongly connected themes:

-the question of teaching science as separate subjects (e.g. Physics, Chemistry, Biology) or as an integrated subject;

-the distinction between content and process of science in an educational context as well as the meaning attached to these terms.

1. Integrated science.

```
                                                     ----->Differences in Content.
                                                     |
                                                     |---->Differences in Process.
                         ------->Separate subjects ------|
                         |                           |---->Practical reasons.
                         |                           |
                         |                           ----->Maintenance of Academic Standards.
Separate subj./integr. sci.----|
                         |                           ----->Unity of Concepts.
                         |                           |
                         |                           |---->Unity of Methods.
                         ------>Integrated Science ------|
                                                     |---->Practical reasons.
                                                     |
                                                     -----> Social Relevance.
```

This theme has been developed in section II.1 Clearly, the main distinction is between views which advocate teaching of science (in secondary schools) in the traditional fashion of three different subjects and those which consider proper the teaching of a unified subject. The reasons given to justify such a choice belong to three different levels: epistemic considerations (differences/unity in terms of concepts and methodology), practicalities and finally, the ad hoc (and rather odd conceptually) polarisation between maintenance of academic standards vs. social relevance.

2. Meaning of content and process in science teaching.

```
                                                 ----->Distinct.
                                                 |
 Relation of Content-Process in Sc. Educ.--------|
                                                 |
                                                 ------>Related.

                                                              ----->Theories-Laws.
                                                              |
                                 -----Meaning of content.------>|---->Obs.-Exp. Data.
                                 |                            |
                                 |                            ----->Sc. Techniques.
 Meaning of Content-Process.------|
                                 |                            ----->Sc. Methods.
                                 |                            |
                                 -----Meaning of process. ----->|---->Data Handling.
                                                              |
                                                              ----->Experimentation.
```

The essence of the discussion (after section II.1) regarding content and process could be encapsulated in two questions:

-are these two notions conceptually related or distinct?

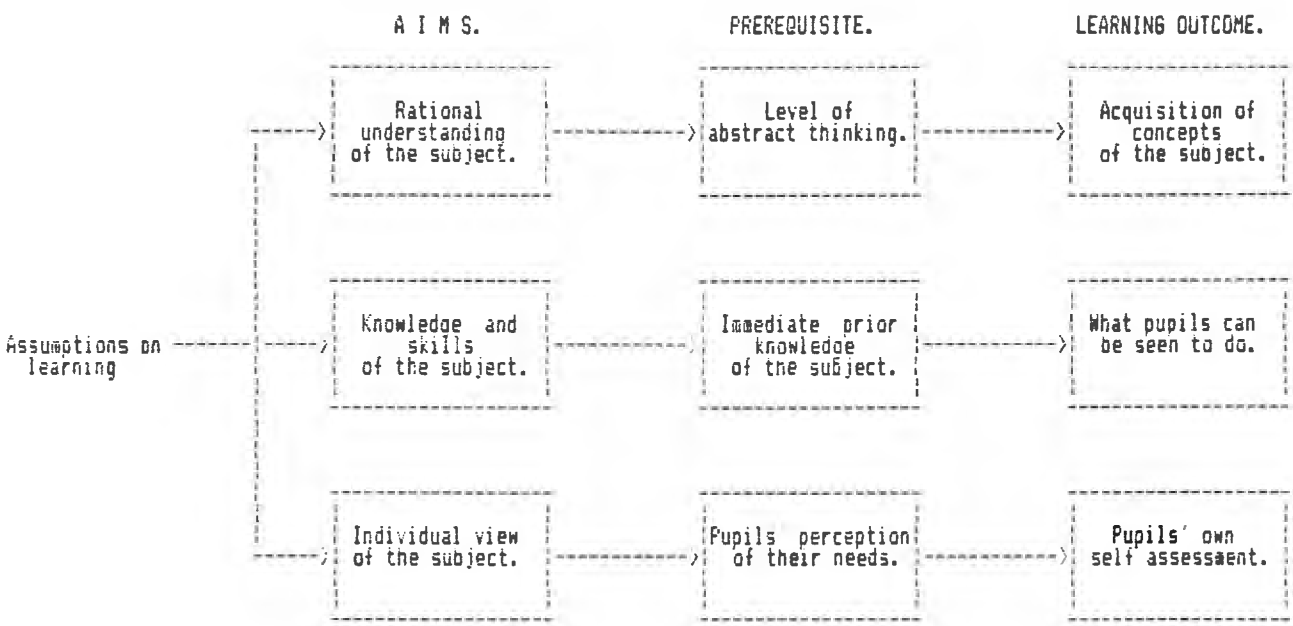
-to what is one referring when using these terms?

As far as the second question is concerned, the alternatives for content are scientific theories and laws, observational and experimental data and finally scientific techniques (or any combination of them) while for the meaning of process any arrangement of scientific methods, handling of data or experimentation techniques is proposed.

C. Pedagogical component.

What is termed the pedagogical component contains assumptions about learning, about instruction and about certain aspects of classroom activities. It should be noted that while the debates regarding each of the two previous components has a definite character (philosophical and pragmatic respectively), in this case the character of the discussion changes from assumptions on learning (which is rather highly structured around theoretically coherent systems) to how certain classroom activities are viewed (by definition non-theoretical in orientation).

1. Assumptions about Learning.



A linear sequence of positions, after the initial branching, is what distinguishes this part of the network from others. The constituent parts of this sequence are: the aims learning activities should have, what their crucial prerequisites are, and finally the basis for assessing their outcome. The systems considered during the discussion about learning assumptions are Cognitivism (emphasis on rational understanding, abstract thinking, acquisition of proper concepts), Behaviourism (knowledge and skills, prior knowledge, assessment on "what they can do" basis) and Constructivism (individuality, self-assessment), as discussed in section II.2.1 Thus, a further element which separates the statements referring to learning from the other statements in this component is that they deal with these issues on the normative level.

2. Assumptions on Instruction.

Orientation of Instruction model.
- Objectives oriented.
- Teachers oriented.
- Balanced orientation.

Crucial element for motivation.
- Active participation.
- Emotional involvement.
- Adequate feedback.

Role of reinforcement.
- Integral/essential part of teaching.
- Occasional use in teaching.
- Irrelevant to teaching.

Presentation of knowledge.
- In small steps.
- The whole idea.

The four networks, which attempt to present systematically the relevant arguments, are simple and straightforward. This is clearly a reflection of the kind of corresponding analysis (section II.2.2), which draws upon certain theories of instruction. For, theories of instruction dealing with, and guided by more practical (than for instance theories of learning) aspects of education, require neither the same degree of theorising nor the same striving for explanatory power.

3. Assumptions about certain aspects of classroom activities.

- Crucial element in science lessons activities.
  - Clear explanations.
  - Pupils' investigations.
  - Guided discovery.
  - Active discussions.
- Traits of a successful teacher.
  - Knowledge of subject.
  - Understanding of pupils' thinking.
  - Effective teaching techniques.
  - Respect for pupils' decisions.

With the above parts the presentation of the entire network which is employed for the development of the research instrument is completed. Again, these networks are very simple. It should be stressed that in this case the categories provided do not have any consistent theoretical background but are an ad hoc organisation of some focal points of arguments (section II.2.3) referring to the practice of teaching.

BIBLIOGRAPHICAL NOTES.

[1]. Halliday, M. A. K. (1978).

[2]. Saussure, F. de, (1916); ed. by C. Bally, A. Sechehaye and A. Riedlinger A., trans. by W. Baskin (1966).

[3]. Firth J. R., (1957).

[4]. Bliss J. and Ogborn J. (1977); Bliss J. and Ogborn J. (1979).

[5]. Bernstein, B. (1973), vol. 2.

[6]. Ogborn J., (1980).

[7]. Bliss, J., Monk, M. and Ogborn J. (1983).

[8]. Ibid., p. 8.

[9]. Ibid., p. 10.

[10]. Ibid., p. 10.

[11]. Ibid., p. 12.

[12]. Ibid., p. 24.

V. GENERAL METHODOLOGICAL CONSIDERATIONS.

A thesis which examines questions concerning philosophy of science can hardly avoid the duty of considering the methodological basis of its own and related research. To conduct such an analysis fully would be to pretend to solve all the problems of educational research, which would be absurdly ambitious. The aims of this chapter are more modest, namely to:

-justify the use of systemic network analysis technique in organising conceptually a questionnaire.

-present a tentative general frame for the methodological location of the relevant previous research.

-close the discussion making some general remarks concerning certain aspects of the methodological debates in educational research.

V.1 Systemic network analysis and questionnaire construction.

Systemic network analysis was proposed and subsequently used for qualitative analysis of data. Why then was it considered useful in constructing a questionnaire?

This question can be discussed in the light of the problems one faces in educational research (as any other research which attempts to extract views or understanding), namely:

a. that of making sure that the respondents understand the issues the research poses (questions) sufficiently, and

b. that the researcher is able to interpret with a reasonable degree of confidence the responses given.

There are roughly speaking two camps with respect to the above problems. The first prefers to use closed-ended questionnaires as an instrument and deals with (a) by pilot testing and checking the validity statistically while (b) is taken to be tackled automatically or "by definition", from the use of closed-ended responses. As Oppenheim [1] maintains, questionnaires consisting of closed-ended questions are preferable to those with open-ended questions, because they ensure the unequivocality in the interpretation of the responses - difficulty (b) above.

In addition, it has been noted that "people are more willing to reveal themselves by checking "those that apply" on a standard list than by answering an open question on the same topic" [2]; because, as Oppenheim [3] puts it "a momentary lapse, a feeling of reticence or the inability to put ideas into words....causes [the] omission of significant points".

However, this approach includes the danger of introducing selective bias i.e. restricting the range of choices the respondent could have made. To overcome this, Oppenheim [4] suggests that a pilot study should be conducted first, in order to reveal the spectrum of alternatives a respondent could opt for. The difficulty tends to be circular: if the pilot study reveals with sufficient clarity what respondents might say, why should it not be the main study? And if not, the difficulty remains; the best that can be hoped for, being that the difficulty is reduced.

The second camp advocates the use of open-ended instruments (e.g. interviews) to overcome difficulties (a) and (b). They deal with (a) by repeated live probing while for (b) they make use of judges for categorising the responses.

The current consensus seems to be that if the research problem is factual (e.g. survey) then for reasons of economy (i.e. large populations, easily comparable answers etc.) closed-ended instruments are to be preferred. On the other hand, if the research problem involves "deep understanding" of a certain situation there are some who advocate the use of closed-ended questions (as for instance Eysenck [5]), while others (e.g. ethnographers [6]) subscribe to the use of open-ended research instruments.

The issues this thesis is dealing with are concerned with "deep understanding", at least in the sense of being far from concrete. Consequently some justification is needed as to why, given these characteristics:

-a closed-ended format was preferred and why

-the application of the systemic network analysis technique was considered suitable in organising the a-priori conceptual analysis.

The research instrument provides a certain number of categories (positions) thus being closed-ended but the treatment of the responses is that of looking for categorical patterns (rather than quantitative modelling). The choice then, of a closed-ended instrument does not mean an exclusively quantitative treatment of the data. Apart from this however, the empirical element of this research is oriented towards answering "what" (i.e. it is exploratory in character) teachers believe rather than "why" they believe so (which arguably does call for in depth interviews). Of course this is far from saying that this choice is unproblematic, in the sense of it being "correct", or that there are no alternative solutions.

Thus, it was thought that instead of providing the alternative choices through a pilot study, a map of the alternatives as emerging from recent debates could be worked out by an a-priori conceptual analysis so as to present a sufficient spectrum of choices. As noted elsewhere, the intention is not to include in the instrument every fine shade of argumentation, whilst preserving if possible the essence of the positions under consideration. This approach would seem to have the advantage of partly dealing with the aforementioned criticism of providing inadequate categories.

Additionally, it could be argued that a factor which contributes to render the philosophical positions under consideration here complex, is that they are dealing with notions and conceptual categories which are interrelated. Therefore, a technique which could enable the instrument "to generate network-like structures in which descriptive categories appear linked in a structure which shows amongst other things, which categories belong within others, which are independent and which are conditional on the choice of others" [7] would be very helpful. For such an analysis would make explicit not only the set of distinctions on which it is based but also the extent to which the relevant ground is covered satisfactorily (in the sense of including a fair number of positions).

A further element which makes the use of the systemic network analysis technique attractive in the context of this thesis is that an individual s conceptual system can be located as a given set of choices in the network. Significantly this is possible without any presupposed acceptance of a specific philosophical or psychological theory. Thus, it should be noted that the actual use made of systemic network technique in this research does presume that meaningful information about philosophical positions can be obtained by asking about them directly. However, this presupposition is not forced by the choice to use a systemic network. By contrast the otherwise somewhat similar repertory grid technique, is inextricably connected with subscription to the theory of personal construct [8].

The systemic network analysis technique provides one also with the facility to focus on either the "collective" (macro) or the "individual" (micro) level. This flexibility is very desirable for the present purposes, because of the need, at least potentially, to connect a broad picture (survey-exploration) with work oriented to understanding individuals. In this study the former approach was chosen: however, given that the a-priori analysis is organised in the form of a systemic network, the basis for communication is established, if the latter level were to constitute the focus of any subsequent study.

Beyond the above general points which support the argument that the systemic network analysis is appropriate as a basis for the construction of a research instrument, there are others concerning the more technical aspects of such a construction.

Specifically, amongst the requirements of a structured instrument the principle of "one concept - one statement" is usually cited [9]. Clearly, by using a network one can in principle proceed in making the necessary distinctions so as to isolate branches which contain only one notion. This could be coupled with developing the instrument in a "stem-leaf" fashion. Thus, the respondent is not presented with a cluster of isolated ideas but with groups of statements (each containing one idea) of which the "logic" of connections is at least potentially discernible. In addition, the relationships between the ideas presented being clear, it can be argued that the responses will be more informed.

Finally, as far as the analysis of the empirical evidence is concerned, this approach enables the researcher to compare a person's manifest relationships between notions in network form, with normative standards or with any other standards one cares to erect.

In summary, it is argued that the technique of systemic network analysis can usefully be employed in the process of the development of the research instrument because:

a. it is flexible in the sense of not itself determining the focus of the study whether on exploration or on the individual level.

b. it facilitates the transformation of complex philosophical arguments into simple statements without losing their essence and in such a way that each statement contains one concept.

c. it makes explicit both the extent to which the relevant ground is covered satisfactorily (in terms of diversity) and the set of distinctions on which the construction of the instrument is based.

d. it provides a basis for the analysis of the data.

V.2 A proposed frame.

The basic assumption of this framework is that movement across different theoretical systems is in principle possible. In other words incommensurability of reasoning [10] (which is at stake here) is not accepted. On the contrary it is assumed here, that different kinds of research can be compared in some common framework.

If differences in philosophical and/or methodological assumptions are hidden because of the use of "poor" distinctions, studies operating under distinct assumptions become "atheoretical and decontextualised" and therefore their arguments or findings run the danger of being unsusceptible to either proper interpretation or relative evaluation. In this case however, the blame should be put firmly on the lack of a proper framework for their location rather than an inherent impossibility of communicating between different pieces of research.

For this reason it is argued that there is a need for an analytical device capable of locating, in terms of methodological-philosophical assumptions, various pieces of research so that these basic assumptions are rendered explicit. This in turn could provide some help towards the objective of disentangling the areas which the studies are addressing, thus permitting a more rational assessment of their respective findings. Here, it is proposed that three different axes should be employed in the construction of such a framework of different methodological assumptions.

The first axis concerns the functional perspective of the study, that is whether or not the study sets out to put norms (normative), to provide descriptions or explore certain area (descriptive, exploratory), to give explanations or interpretations (explanatory, interpretative), or to intervene and change a certain situation (interventionist). Usually, studies fall into one of these categories but in principle there is no reason why a study could not be for instance, partly descriptive and partly explanatory.

The second axis concerns the kind of instrument used (if the study has an empirical element). Questionnaires (both closed-ended and open-ended), observation (systematic and unscheduled) and interviews (pre-structured and free) are the options which cover this level.

The last axis is seen in terms of the treatment of evidence. The analysis of evidence could be either quantitative or qualitative. In this case "either, or" should not be taken as indicating exclusiveness.

The following table T5.1 depicts this proposed framework.

Axis.	Alternatives.				Compatibility.
Functional perspective	Normative	Descriptive Exploratory	Explanatory Interpretative	Interventionist	+ V,H
Type of Instrument		Questionnaire ------------- Closed ended Opened ended	Observation ----------- Systematic Unscheduled	Interviews ---------- Pre-structured Free	+ V,H
Analysis of evidence		Qualitative	Quantitative		+ V,H

Where +: possibility of co-selection. and H: Horizontally.
‡: mutually exclusive. V: Vertically within the same level.

T A B L E T5.1: A proposed framework for the methodological location of studies.

In addition, speaking now in terms of the philosophical assumptions made, there are two further ways in which a study could be characterised. The first refers to the philosophical perspective of the study in the sense of level II philosophical systems (as analysed in chapter III.6). Central to these systems is the distinction between observation and theory. Scientific realism, positivism (and empiricism), pragmatism and phenomenology constitute possible alternatives. Given the fundamental differences in basic assumptions between them, one could argue that these systems are mutually exclusive.

The second point deals with epistemic aspects. More specifically studies could be categorised according to whether communication between different systems of knowledge is considered in principle possible, or impossible (incommensurability) in their context. This distinction is almost identical with Wittgenstein's distinction [11] between open and closed systems respectively. Ethnography with its relativistic overtones is the currently prevailing paradigm of closed systems. Alternatives on this level cannot but be seen as mutually exclusive.

Regarding the compatibility of the above aspects, it could be argued that closed systems (in the epistemic sense) are incompatible with the first three level II philosophical systems (i.e. scientific realism, pragmatism, and positivism-empiricism), whilst open systems (i.e. communication in principle possible) can fit with any of these systems. A fuller account of the relevant argument is given in section III.6.4.

As far as the articulation of methodological and philosophical -epistemic assumptions is concerned, there seems to be no reason to consider any combination impossible. What is important here is not the explicit assumptions per se, but rather the extent to which one adheres to them when either arguing or analysing data. It is argued in the next section that such distinctions, if made, need to be applied with greater care than is sometimes done.

Finally, it should be restated that no claim is made that the use of any such framework solves the problems of educational research. It is rather an exercise aiming at some tentative suggestions, which in any case unavoidably reflect personal presuppositions.

V.3 Some general remarks.

Regarding the above frame there is a general methodological issue which warrants some comment. In the debates referring to perspectives of educational research use is often made of certain dichotomies.

Applying these dichotomies, studies are classified as for instance, "positivistic" versus "ethnographic" [12], "traditional" ("psychometric") versus "phenomenological" [13], "normative" or "nomothetic" versus "ideographic" [14], "qualitative" versus "quantitative" [15], "using inventories" versus "using interviews" [16], or "empiricist" versus "interpretative" [17] et al. Furthermore, there are instances where inferences about relationships between these dichotomies are made e.g. implications of the type:

inventory ----> quantitative ---- positivistic
versus
interviews and/or observation ----> qualitative ----> ethnographic [18].

Such taxonomies are arguably not altogether satisfactory. The reason can be sought in the objective any such characterisation sets out to achieve. If its aim is to devise an analytical instrument, it fails both because such distinctions provide only a simplified - usually linear - model and because the reasoning and justification for making the distinctions is far from undisputable. On the other hand, such terms are also employed with an explicit or implicit intention to be evaluative: to decide whether the research is acceptable or not. But clearly it is not sufficient to dismiss (or to praise) a certain study on the basis of a rather unsatisfactory analytical tool.

To elaborate on the argument concerning such distinctions as an analytical framework, a first remark concerns their scope. These dichotomies contrast only two positions. Thus, their scope cannot but be limited. Whatever the significance of the positions taken to be juxtaposed is, the fact remains that the theoretical and/or methodological assumptions of a certain study need not conform to any such simple frame. This is not to say that this happens because alternative frames are in a sense intrinsically incapable of communicating one another. It is rather to say that the spectrum of coherent sets of theoretical and/or methodological assumptions is of much greater breadth than that which a single distinction would lead one to believe. Of course, one cannot dismiss the trade-off of accuracy and precision against generality. Their balance is the point.

Secondly, there is a remark concerning conceptual precision. Terms like positivism, phenomenology, ethnography are borrowed from other fields, e.g. philosophy of science and anthropology, where they are well established and acceptable. It is not unreasonable, therefore, to assume that they ought to be used either in the same fashion in which they are applied in their fields of origin, or if not, that the modifications untertaken should be made explicit. If this is not done then a proliferation of terms which in some cases intend to convey the same meaning and in other cases blur necessary distinctions is liable to occur.

To illustrate very briefly these points two examples will be offered. Take for instance Piagetian-oriented studies. If one uses the distinction positivism-phenomenology, then, despite the fact that both positivism and phenomenology are very important currents of thought, one can not locate studies of the Piagetian school in these terms. For, Piaget [19] was disposed to think in terms of universals (e.g. the stages of cognitive development are cross-cultural), to refer to just one of his assumptions which more obviously violates ethnographic assumptions. And, since he has explicitly argued against positivism one cannot conclude that his studies fall in the positivistic camp [20] either.

Since one may argue that Piagetian studies are a very special case due to his particular interest in epistemology as well as his specific philosophical position, the behaviourist tradition as represented by Skinner can be considered instead. At first sight this work could be characterised as positivistic - certainly not as ethnographic. But this crude distinction misses the very particular characteristics of Skinner s explicit philosophical assumptions. As Margolis [21] argues, this system should be considered more akin to scientific realism (or reductionist materialism in Smart's terminology [22]), than to any other ontological system.

What the above examples seem to indicate is either that the location of studies across single dichotomies cannot be done (Piagetian studies), or if such a classification is applied it is not helpful, if not misleading (behaviourism).

In conclusion, it is argued here that the use of too global or too polarised distinctions can do little in helping one to evaluate the findings of previous research in addition to restricting the choice of combinations of compatible methodological tools which may prove to be of interest.

BIBLIOGRAPHICAL NOTES.

[1]. Oppenheim, A. N. (1972).

[2]. Berdie, D. R. and Anderson, J. F. (1974), p. 135.

[3]. Oppenheim, A. N. (1972).

[4]. Ibid.

[5]. Eysenck, H. J. (1952).

[6]. Hammersley, M. and Atkinson, P. (1983), ch. 1.

[7]. Bliss, J., Monk, M. and Ogborn, J. (1983), p. 4.

[8]. Labaw, P. J. (1980), pp. 143-151.

[9]. Hollis, M. and Lukes S. (1983), pp. 10-11

[10]. Brand G. (1979), pp. 121 and 124.

[11]. Fransella, F. and Bannister, D. (1977), p. 1-4.

[12]. M cIntyre, D. I. (1980), pp. 2-30.

[13]. Entwistle, N. and Hounsell P. (1979), pp. 359-363.

[14]. Driver, R. and Easley, J. (1978), p. 62-63.

[15]. Entwistle, N. (1984), pp. 12-13 and 24.

[16]. Ramsden, P. (1984), pp. 158-160.

[17]. Adelman Clem and Young M. F. D. (1985).

[18]. Hamilton D. and Delamont S. (1974), p. 7.

[19]. Piaget, J. (1972), pp. 36-36.

[20]. Ibid., ch. 4.

[21]. Margolis, J. (1984), ch. three.

[22]. Smart, J. J. C. (1963).

VI. REVIEW OF THE RELEVANT LITERATURE.

VI.1 Introduction.

The purpose of this chapter is to locate the present research with respect to the body of relevant literature (within science education). The basic assumption is made that research done from different points of view (some would say within different paradigms) can in fact be compared [1]. For, it has already been argued that the notion of incommensurability hinders rather than helps educational research [2], in addition to it being philosophically unsound [3].

The structure is as follows:
(a) a descriptive overview of other research
(b) a critique of previous research
(c) the location of the present study in terms of other work described.

The descriptive overview (and to some extent the other sections of this chapter) is based on a classification of features of research, so as to bring a considerable number of studies into relationship with one another. This classification will now be explained.

VI.2 The frame: A set of distinctions.

The distinctions used in the discussion of the relevant literature are:

A. The character of the studies under review.
B. Their "subject matter".
C. Their "general" scope.

D. Their "philosophical" scope.

E. The kinds of techniques used by these studies for the gathering of evidence (where relevant).

A. The character of a study is described as either being descriptive/exploratory or normative (the latter being those in which a certain position is proposed or defended). This distinction is similar to that between empirical and non-empirical studies. For this reason two ad hoc categories are employed here: on the one hand descriptive/exploratory studies with a strong empirical element and on the other hand normative/ideothetic ones.

A finer distinction is that between the ideothetic studies, which stress the relevance of philosophy/sociology/history of science to science education, and those studies which focus on the relation of a particular system of thought or a model of science to a certain aspect (or aspects) of science education. In the following, studies belonging to the first of these groups will be referred under the heading "relevance", while for the second group the heading "application" will be used.

B. The "subject matter" can be viewed in two senses:

1. Firstly, the aspects of education which the research addresses. The relevant dimensions here include studies which focus on: students' views, teachers' views, curriculum projects, policy formulation, teaching styles/practices and reviews. Given that this thesis is concerned with teachers and curricular-pedagogical issues, studies referring exclusively to students will be given less attention.

2. Secondly, the character of the issues concerned in these studies, i.e. philosophy of science per se on the one hand, and the connection of philosophy of science with curricular and pedagogical issues, on the other.

In addition, it is necessary to distinguish between studies focusing on teachers' and/or students' attitudes towards science; on the understanding of certain philosophical and/or sociological aspects of scientific knowledge and finally on eliciting views on the philosophical (and partly sociological) dimensions of scientific knowledge.

The last aspect is clearly relevant to this thesis. Understanding of the philosophical basis of scientific knowledge is also highly relevant. Attitudes towards science, however, are something of a different matter. Certainly, attitudes towards science are to some extent derived from one s views about its philosophical basis. The point here is two-edged: i.e. firstly, attitudes on the one hand and views/understanding on the other are conceptually distinct and secondly it is uncertain to what extent attitudes are formed exclusively on the basis of a rational understanding of the philosophical basis of certain issues. Of course it would be an uncomfortable position if, for instance, someone considered science as seeking the truth and as simultaneously being detrimental to society.

C. The scope of the studies describes whether they take into account only one position as opposed to those which encompass more than one position. A finer distinction, in so far as the one dimensional studies are concerned, is based on the explicitness of the position adopted.

D. The inclusion of ontological concerns constitutes a further important point. As has been argued, ontology is indispensable when dealing with epistemological problems. On this basis two kinds of studies can be discerned: on the one hand there are those in which consideration is given to the connections between epistemological and ontological levels and on the other hand those which regard such connections as beyond their concern.

E. The final dimension concerns research techniques (applicable only to those studies which purport to map peoples' views). These techniques can be classified into closed-ended questionnaires, or into less structured forms (interviews - whether prestructured or not; essay writing etc.).

A presentation of these distinctions in a systematic way is attempted by the network shown in the next page.

Finally, it should be stressed that this set of distinctions, which cut across the various perspectives from which a systematic study of science teaching could be seen, is the basis of the following descriptive analysis. Given though that any such selection of distinctions has an inevitably personal bias, this bias cannot avoid being present throughout the discussion.

```
                        ---->descriptive/exploratory (empirical).
                        |
                   -----|
                   |    |
                   |    ---->Analytical and reviews.
                   |
 -Character--------|
                   |
                   |
                   ------>Normative/ideothetic (no empirical).

                         ---->closed-ended instrument.
                         |
                         |
 -data collection--------|
                         |
                         |
                         ---->open-ended instrument.


                                        ---->teachers' views.
                                        |
                                        |
                    -aspects of sc.-----|---->students' views.
                       education        |
                                        |
                                        ---->science curriculum.
 -Subject matter
                                ---->philosophy of science.
                                |
                    -context----|
                                |
                                ---->philosophy of science-"pedagogy".


                                            ---->explicit.
                                            |
                        ----->one position--|
                        |                   |
                        |                   ---->implicit.
                        |
          -Scope -------|
      (epistemology)    |
                        |
                        ----->several positions.

                             ---->ontology not included.
                             |
          -Scope ------------|
 (epistemology-philosophy)   |
                             ---->ontology considered.
```

VI.3 A "descriptive" analysis: a cartography of the ground.

In the following tables the 81 studies examined have simply been classified according to the distinctions suggested above. Comments beyond those intended to clarify aspects of the description are withheld for the next section. Tables T6.1 and T6.2 constitute a taxonomy of the studies as either normative/ideothetic (table T6.1) or exploratory/descriptive (table T6.2).

NORMATIVE - IDEOTHETIC STUDIES.

Relevance		Application	
Butzow and Linz	[4]	Abimbola	[28]
Conant	[5]	Akeroyd	[29]
Connelly	[6]	Cawthron and Rowell	[30]
Connelly	[7]	Donnely	[31]
Elkana	[8]	Finley	[32]
Elkana	[9]	Forge	[33]
Fenstermacher	[10]	Freundlich	[34]
Gardner	[11]	Hamilton	[35]
Gardner	[12]	Heath	[36]
Herron	[13]	Jones, V. J.	[37]
Jones, O. M.	[15]	Knape and Rosewell	[38]
Ivany	[16]	Laura	[39]
McMurrin	[14]	Margetson	[40]
Lind	[17]	Nock and Nelson	[86]
Nadeau and Desautels	[18]	Richardson and Boyle	[41]
Nagel	[19]	Robinson M. C.	[42]
Phillips	[20]	Smolicz and Nunan	[43]
Price	[21]	Steiner	[44]
Roberts and Russel	[22]	Swartz	[45]
Robinson, J. T.	[23]	Tawney	[46]
Robinson, J. T.	[24]	Wagner	[47]
Rogers	[25]	Whitaker	[48]
Summers	[26]	Westwood	[49]
Tischer, Power and Endean	[27]	Wright	[50]

T A B L E T6.1

EXPLORATORY - DESCRIPTIVE STUDIES.

Exploratory		Reviews	
BSSC	[51]	Aikenhead	[76]
Behnke	[52]	Doran, Guerin and Cavalieri	[77]
Bileh and Malik	[53]	Durkee	[78]
Brown	[54]	Hodson	[79]
Carrey and Stauss	[55]	Jungwirth	[80]
Cooley and klopfer	[56]	Lucas	[81]
Crumb	[57]	Mackay	[82]
Dibbs	[58]	Munby	[83]
Kimball	[59]	Schmidt	[84]
Korth	[60]	Trent	[85]
Mitias	[61]		
Moore and Sutman	[62]		
Noll	[63]		
Ogunniyi	[64]		
Ogunniyi and Pella	[65]		
Orsini-Romano	[66]		
Rowell and Cawthron	[67]		
Schwirian	[68]		
S.L.C.	[69]		
Stice	[70]		
Swan	[71]		
Tamir	[72]		
Welsh and Pella	[73]		
Wilson	[74]		
Zupp	[75]		

T A B L E T6.2

It should be added that the distinction between normative-idiothetic and exploratory-descriptive studies is not altogether clear cut: some of the exploratory studies have a normative element as well. A relevant example is Dibbs' work [58]. Dibbs argues that some aspects of teaching styles, for instance the use of experimental work, are related to teachers' views on philosophy of science. Furthermore, he argues that science teachers in schools have and should have some understanding of the relevant issues and that this is why it is possible to construct a test to measure understanding (to be judged against the general cultural background of teachers) of philosophy of science. In such cases, the classification took into account the predominant character of each study.

Table T6.3 focuses on the "subject-matter" of the studies.

THE "SUBJECT MATTER" OF THE STUDIES.

			Teachers	Students	Curricul.	Pedagogy
	Abimbola	[28]			*	
	Akeroyd	[29]			*	
	Cawthron and Rowell	[30]			*	x
N	Donnely	[31]			*	
	Finley	[32]			*	*
O	Forge	[33]			*	
	Freundlich	[34]			*	
R	Hamilton	[35]				*
	Heath	[36]				*
M	Jones, V. J.	[37]			*	
	Knape and Rosewell	[38]	*			
A	Laura	[39]			*	
	Margetson	[40]			*	
T	Nock and Nelson	[86]			*	
	Richardson and Boyle	[41]			*	
I	Robinson M. C.	[42]			*	
	Smolicz and Nunan	[43]			*	*
V	Steiner	[44]			*	*
	Swartz	[45]				*
E	Tawney	[46]				*
	Wagner	[47]			*	
	Whitaker	[48]			*	
	Westwood	[49]			*	
	Wright	[50]			*	
	BSSC	[51]	*	*		
	Behnke	[52]	*			
E	Bileh and Malik	[53]				
	Brown	[54]	*			
X	Carrey and Stauss	[55]	*			
	Cooley and Klopfer	[56]	x	*		
P	Crumb	[57]		*		
	Dibbs	[58]	*			
L	Kimball	[59]	*			
	Korth	[60]		*		
O	Mitias	[61]		*		
	Moore and Sutman	[62]		*		
R	Noll	[63]		*		
	Ogunniyi	[64]	*			
A	Ogunniyi and Pella	[65]	*			
	Orsini-Romano	[66]	*			*
T	Rowell and Cawthron	[67]	*			
	Schwirian	[68]		*		
O	S.L.C.	[69]		*		
	Stice	[70]		*		
R	Swan	[71]		*	*	
	Tamir	[72]		*	*	
Y	Welsh and Pella	[73]		*		
	Wilson	[74]	*			*
	Zupp	[75]	*			*

T A B L E T6.3

Table T6.3 shows a strong relation between the character of studies (normative/ideothetic or exploratory/descriptive dimension) and their subject matter. Studies belonging to the former group tend to a large extent to deal with curricular issues, some attention being paid to the connection with pedagogy, together with an analysis of scientific knowledge along philosophical and/or sociological dimensions. Conversely exploratory/descriptive studies focus mainly on a recording of teachers' and students' views with regard to these issues.

The strength of this relation can be illustrated quantitatively, by the following table:

	Teachers-Students	Curriculum-Pedagogy
Normative	1	23
Exploratory	20	5

T A B L E T6.4: Character and subject matter of studies.

Some of the entries in table T6.3 are particularly worthy of comment. Cawthron and Rowell [30], Finley [32] and Smolicz and Nunan [43] are of interest because they discuss curricular and pedagogical issues in the light of considerations drawn from philosophy and sociology of knowledge. However, the usefulness of their accounts is limited by their relatively narrow focus. That is, the first study is of considerable depth in philosophical terms, but on the one hand deals only with the Piagetian current of pedagogy and on the other hand the curricular considerations, while worthwhile, lack empirical evidence. The same applies to the third study, with the further limitation that it deals mainly with pedagogy. Regarding the second of these studies, a limitation is that only the empirical inductivist position is considered to represent philosophy of science. A fourth study, by Knape and Rosewell also warrants comment [38], since it is the only one where teachers' views are treated in an ideothetic fashion.

Tables T6.5 and T6.7 list studies in terms of their scope.

THE SCOPE OF THE STUDIES.

	One Position.		More than one Position.	
E	BSSC	[51]	Dibbs	[58]
	Behnke	[52]	Ogunniyi	[64]
X	Bileh and Malik	[53]	Ogunniyi and Pella	[65]
	Brown	[54]	Rowell and Cawthron	[67]
P	Carrey and Stauss	[55]		
	Cooley and Klopfer	[56]		
L	Crumb	[57]		
	Kimball	[59]		
O	Korth	[60]		
	Mitias	[61]		
R	Moore and Sutman	[62]		
	Noll	[63]		
A	Orsini-Romano	[66]		
	Schwirian	[68]		
T	S.L.C.	[69]		
	Stice	[70]		
O	Swan	[71]		
	Tamir	[72]		
R	Welsh and Pella	[73]		
	Wilson	[74]		
Y	Zupp	[75]		
	Nock and Nelson	[86]	Abimbola	[28]
N	Wagner	[47]	Akeroyd	[29]
	Whitaker	[48]	Cawthron and Rowell	[30]
O	Steiner	[44]	Donnely	[31]
	Swartz	[45]	Finley	[32]
R			Forge	[33]
			Freundlich	[34]
M			Hamilton	[35]
			Heath	[36]
A			Jones, V. J.	[37]
			Knape and Rosewell	[38]
T			Laura	[39]
			Margetson	[40]
I			Richardson and Boyle	[41]
			Robinson M. C.	[42]
V			Smolicz and Nunan	[43]
			Tawney	[46]
E			Westwood	[49]
			Wright	[50]

T A B L E T6.5

Again, there is a strong relation between scope and character (normative versus exploratory dimensions) as shown in table T6.6

	One Position.	More than one Position.
Exploratory	21	4
Normative	5	19

T A B L E T6.6: Scope of exploratory and normative studies.

PHILOSOPHICAL POSITIONS TAKEN INTO ACCOUNT.

			Ind.	H.-D.	Cont.	Rel.	Per.
	Abimbola	[28]			*	*	
	Akeroyd	[29]		*	*	*	
	Cawthron and Rowell	[30]	*	*	*		
N	Donnely	[31]		*	*		
	Finley	[32]	*				
O	Forge	[33]		*			
	Freundlich	[34]		*	*	*	
R	Hamilton	[35]	*		*		
	Heath	[36]	*				
M	Jones, V. J.	[37]	*	*	*		
	Knape and Rosewell	[38]					x
A	Laura	[39]	*	*			
	Margetson	[40]	*				
T	Nock and Nelson	[86]				*	
	Richardson and Boyle	[41]	*	*	*		
I	Robinson M. C.	[42]	*	*	*	*	
	Smolicz and Nunan	[43]	x	x	x		*
V	Steiner	[44]					*
	Swartz	[45]	*	*			
E	Tawney	[46]	*	*	*		
	Wagner	[47]			*		
	Whitaker	[48]			*		
	Westwood	[49]		*	*		
	Wright	[50]	*	*	*	*	
	BSSC	[51]					*
	Behnke	[52]					*
E	Bileh and Malik	[53]					*
	Brown	[54]					*
X	Carrey and Stauss	[55]					*
	Cooley and Klopfer	[56]		x			*
L	Crumb	[57]					*
	Dibbs	[58]	*	*			
O	Kimball	[59]					*
	Korth	[60]					*
R	Mitias	[61]					*
	Moore and Sutman	[62]					*
A	Noll	[63]					*
	Ogunniyi	[64]	*	*			
T	Ogunniyi and Pella	[65]	*	*			
	Orsini-Romano	[66]					x
O	Rowell and Cawthron	[67]	*	*	*		
	Schwirian	[68]					*
R	S.L.C.	[69]					*
	Stice	[70]					*
Y	Swan	[71]					*
	Tamir	[72]					*
	Welsh and Pella	[73]					*
	Wilson	[74]					*
	Zupp	[75]					*

TABLE T6.7

Table T6.7 shows which epistemological positions have been taken into account in the various studies. It is noteworthy that the great majority (20 out of 25) of exploratory studies are constructed around only one philosophical position as opposed to normative studies, which usually consider more than two positions.

There are some studies which require individual attention. TOUS for example, being of interest due to its wide use, lacks any explicit philosophical basis, but as Dibbs [87] argues, the hypothetico-deductive model predominates it. The studies by Dibbs [58], Ogunniyi [64] and Ogunniyi and Pella [65] are a step in the right direction, being constructed around two philosophical systems, namely, inductivism and hypothetico-deductivism. Even better in this respect, is the study by Rowell and Cawthron [67], in which three positions namely, inductivism, hypothetico-deductivism and contextualism are considered explicitly. However, none of the last three studies incorporates any ontological dimension, which in the view of this thesis is indispensable in an educational interpretation of the findings. Lastly, Orsini-Romano [66] deals with some pedagogical implications without elaborating on the link between these and philosophical (and/or sociological) considerations.

Amongst the normative studies, there are many (19 out of 24) which take more than two positions into account. This discrepancy between normative and exploratory studies is unusual; one might even expect normative studies to put forward a certain philosophical system. The fact that this is not the case could be explained if one considers the time element. Most of the monothematic - exploratory studies are rather dated; the more recent ones having been developed along more than one dimension. On the other hand, the older normative studies are centred around the issue of the relevance of philosophical and/or sociological analyses of knowledge to the teaching of science.

Taking 1975 as a base year, table T6.8 not only provides some empirical evidence in support of this point but also indicates how the general trends and focus have developed.

	NORMATIVE		EXPLORATORY	
	Relevance	Application	One position.	Many positions.
Pre-1975	16	2	21	-
Post-1975	6	22	-	4

T A B L E T6.8: Trends and focus of studies.

Another issue to be considered is the avoidance of the ontological question in either the normative or descriptive studies, with the exception of those by Nadeu and Desautels [18], Forge [33] and Knape and Rosewell [38]. The first of these however, concentrates more on the relevance, as opposed to application aspects of the philosophy-science teaching relationship (table T6.1), while the third deals with issues on the ontological level, excluding the epistemological level. Important in this respect are Forge's conclusions on the need to distinguish in the teaching of science between the realist and instrumentalist positions.

As already mentioned, exploratory studies dealing with the ontological question are notably absent. A tentative explanation for this lies in the prevailing rigid compartmentalisation of knowledge. Thus, research in the field of science education tends to draw upon philosophy of science (level III systems), as opposed to philosophy in general (level I systems).

What remains then, is an examination of the body of relevant studies with an empirical element, in terms of the sort of instrument which they have used for the collection of evidence. Only Mitias [61] has employed the instrument of essay writing. In all the other cases a closed-ended questionnaire has been employed.

The strong preference for closed-ended instruments is perhaps surprising - given the complexity and fluidity of the issues involved. However, one cannot overlook the need for the researcher to have some security (in terms both of facilitating the practical aspects of the conduct of the research and of having a structured means for the analysis of the results) when dealing with an area of such complexity. Nevertheless, in the case of a closed-ended instrument, problems of whether the questions (statements) are well founded and intelligible, are unavoidable. The reasons for using a closed-ended instrument in the present thesis were discussed in chapter V.

What the above descriptive overview seems to indicate is that:

a. from the standpoint of science education there is a considerable interest in this area given the number of relevant papers;

b. the issues have been dealt with at both the normative and the exploratory level;

c. taking into account the philosophical scope particularly of the exploratory studies (even recent ones) a discussion is needed as to whether there are some problematic aspects in the way research was founded conceptually;

d. regarding the subject matter of the exploratory studies and specifically those of a wider philosophical scope, the link between on the one hand curricular and pedagogical and on the other philosophical-epistemological issues has not been study.

VI.4 A critique: The comprehensiveness of the literature.

The intention in this section is to answer the question "where does this thesis stand?" through a critique which will suggest that a number of areas have not been addressed in the existing body of literature. The distinction between exploratory/descriptive and ideothetic/normative studies will be applied here.

It should be clarified however that given the orientation of this study, the subsequent discussion will focus on the exploratory/descriptive studies, whilst for the normative ones the intention is to indicate the general direction of their suggestions rather than analyse them in any detail.

VI.4.1 Exploratory/Descriptive studies.

Studies belonging to this group are listed in table TVI.1b. The discussion here will have the twofold orientation of, on the one hand establishing a four-point general critical analysis in terms of theoretical/methodological assumptions and on the other hand, of bringing this analysis to bear on the respective findings.

1. General critique.

As indicated by tables T6.7 and T6.8, the position projected by those exploratory studies which are rather older (pre-1975), is often "personal", i.e. an idiosyncratic collage from various philosophical systems, without any attempt to explicitly define the source of these constituent parts, as Lucas [88] points out. He cites, along with a considerable number of other instances, the following (item 43 taken from TOUS), TOUS being considered amongst the more successful instruments of this type:

"Which of the following is the best description of a scientific law:

A. It is an exact report of the observation of scientists.

B. It is a generalized statement of relationships among natural phenomena.

C. It is a theoretical explanation of a natural phenomenon.

D. It is enforced by nature and cannot be violated."

The "correct" answer according to the test is B. It can be argued however, that there are doubts as to what extent this is an appropriate description for one espousing an inductivist position.

This tendency (of the instruments developed often to lack an explicit specification of the philosophical assumptions or at least not to have them explicitly acknowledged) seems to stem from the fact that most of these studies fail to recognise that conflicting models of science from a philosophical (and/or sociological) standpoint do exist, as Lucas [89] remarks. This lack of an a-priori analysis leaves one with the impression that the writer of each instrument presupposes one single valid and universally indisputable model of science (see the above example from TOUS). Here, the distinction between exploratory and normative work is pertinent. It is one thing to propose and/or defend a certain philosophical system, and quite another when engaging in exploratory work with the purpose of recording somebody else's views, to obscure the fact that conflicting - and sometimes quite incompatible - systems of thought do in fact exist. This is not to say that one should not engage simultaneously in both activities. Rather, a clear demarcation line between these two sorts of studies should be drawn.

If this is the case, three objections can be lodged immediately. Firstly, the absence of explicit specifications regarding the adopted position(s) makes it difficult to compare the results of the various studies. Secondly, any attempt to map a particular situation (e.g. teachers' philosophical views), using a "personal" position, may be an unorthodox way to tackle this problem, as one cannot expect others to be aware of one's own personal view. Lastly, any such collage (without a careful conceptual analysis of the issues involved) can easily end in a position containing internal contradictions from a philosophical standpoint.

There are however instruments which do take into account more than one position. Nonetheless it is argued that it is not enough to include only some positions. Every attempt should be made to include a reasonable number of philosophical systems, so as to cover the whole spectrum adequately. Otherwise, the introduction of bias in the instrument (since closed-ended instruments constitute the research tools in this area) is difficult to avoid.

Thus, the first point of the critique is that most of the already existing instruments fail to recognise sufficiently the diversity of philosophical thought and the existence of conflicting models of science.

Another related point is that philosophy of science, apart from its diversity in terms of systems which expresses distinct currents of thought, is concerned with issues of great complexity which cover a number of constituent topics e.g. scientific methodology, criteria of demarcation etc. Clearly, views with regard to these topics are interconnected. On the other hand however, there is no compelling reason to presuppose an absolute consistency of the views of people who are not professional philosophers i.e. to presuppose that one subscribing to inductivism as far as scientific methodology is concerned will also adopt automatically the same system for the theme of scientific growth. Taking these on board, one could criticise the practice of reporting the results (which is followed almost uniformly) in the form of global scores. Of course, as Gardner [90] demonstrates in his review, this has nothing to do with the application aspect of the instruments. Munby [91] commenting on this writes that "there is a general lack of coherent theoretical constructs in many scales, so that as many as three quite separate issues are often fused into a single scale without subscales".

The third point refers to the inclusion of the "ontological problem" because epistemology by its very nature is connected, more than anything else, with the ontological issue and only by considering epistemological problems in their ontological context, can educational problems connected with epistemological issues become meaningful. Thus, while there are plenty of studies concerned with epistemological issues (styles of reasoning et al.) and some which deal with ontology, there are none which try to forge a link between epistemology and ontology.

It may sound abstract and could even be regarded as impertinent to try to establish a relationship between epistemology and ontology on the one hand and science teaching on the other. Indeed, there exists a view which appears to dispute the meaningfulness of such an attempt. Wilson and Cowell [92] argue that "anyone who believed that what (say) Popper or Kuhn were concerned with was central to education in science would surely either not know the kind of issues these philosophers were trying to tackle or not have a firm grasp of the idea of education". There seem to be three reasons why this brisk dismissal of the importance of philosophy of science for education is not wholly valid:

-Firstly, generally speaking, it is one thing to claim that philosophical considerations are central to, and quite another to argue that they have some relevance to science education. The argument is not about the centrality of philosophical issues to education, as a close inspection of any of the relevant studies shows. Rather it is about their relevance; and empirical evidence exists to show that teachers at least accept this view, (e.g. Dibbs [58]).

-Secondly and more specifically, it is the view taken in this thesis that considerations on a "technical" (epistemological) level lacking articulation with regard to the ontological considerations are difficult to interpret educationally so that their impact is necessarily limited, particularly in the areas of content organisation and students' attitudes towards science.

-Thirdly, there is Scheffler's [93] argument, seemingly strange, that whilst philosophical considerations may be unnecessary for a scientist they are quite essential for science teachers. In this, he draws the very valid distinction between education in science (which requires a philosophical understanding of science, as opposed to understanding of the technicalities of philosophy of science) and training in science (which does not) [94]. This distinction is further elaborated by Margetson [95] and others.

This argument gains further support in the currently growing body of research concerning the significance and impact of children's knowledge prior to science teaching. As already indicated in the previous chapter, several attempts to identify the differences in the starting points of these studies (either in terms of methodology, or the theoretical framework employed) so as to render their findings meaningful have been made (e.g. Solomon [96], Driver and Erickson [97]). These attempts focus on the methodology employed or on the declared objectives. It is clear however, that behind both the methodological aspects and the objectives, an ontological position can be discerned. For instance, if one tries to depict pupils' ideas about a certain topic in Physics through ethnomethodology, claiming subsequently that teachers ought to help pupils to discover their own science - in other words to formulate their own scientific theories - it follows that the ontological assumption of the researcher could not be realism. Otherwise, one could not easily defend the position that teachers should help pupils to form their own ideas on science if, roughly speaking, reality could be used as a criterion against which the "correctness" or " wrongness" of a certain scientific claim can be judged.

The third point therefore, is that if one accepts the relevane of philosophical considerations to the teaching of science, then information about teachers' epistemological beliefs might be interpreted more meaningfully in educational terms if they are seen in conjuction with their ontological views.

An inspection of tables T6.3 and T6.4 reveals that attention is paid to the connection between philosophical-epistemological issues with curriculum and pedagogy, at the exploratory level. This contrasts with the assertion by Bruner, that "there is a lack of integrating theory in pedagogy....in its place there is principally a body of maxims" [98]. This in turn, should be seen in the light of the orthodoxy that the study of education depends on four disciplines - history, philosophy, psychology and sociology - and lies in the application of these disciplines to a wide range of educational issues. While psychology appears to be considered as most immediately relevant to teachers' work [99], philosophy and sociology are generally recognised as providing the link for any attempt to formulate and justify educational policy. However as Morrison and McIntyre [100] argue, the coordination of teaching in teacher training colleges is less than adequate.

A note of caution should be added. Recently as Hodson observed, "...there does seem to be an assumption that teacher's epistemological views determine his/her choice of learning method" [101]. He considers the assumption of an invariable relation between philosophical views and beliefs about how science should be taught to be potentially damaging. While this thesis does not support such a robust causation, as evident from detailed analysis and empirical evidence - this is not to say that no relationship exists at all.

Indeed, at the level of empirical research, as argued by Eggleston a way of dealing with the methodological problems of research concerning "intellectual transactions" in the classroom "rests on the assumption that teachers knowledge of and beliefs about the disciplines they teach and the way their pupils learn determines ... the kind of [classroom] interactions they stage manage" [102]. Furthermore at a theoretical level, as the philosophy of psychology indicates, there are strong arguments pointing towards accepting in principle a certain relationship between philosophical and "pedagogical" assumptions, as argued by Margolis [103] and Wetherick [104]. Again, this is not to say that there is necessarily a congruence between teachers' views and their actual teaching practice.

Thus, the last point that emerges is that any detailed consideration as to how teachers' philosophical assumptions are connected with their "pedagogical" assumptions, tends to be missing.

2. Discussion of the findings.

Taking these points into account, the discussion of the data provided by the previous studies cannot be anything but cautious.

To organise the discussion the network displayed in section VI.2 will be employed. The main distinction relevant here is between those studies which are exploring teachers' views on the basis of an instrument which constitutes a personal stance and those which are constructed around some established (within philosophy of science) positions.

The majority of the former studies tend to reflect an inductivist image of science (a notable exception is that of TOUS which projects a rather hypothetico-deductive position as already mentioned). Indeed, as

Gauld and Hukins [105] report, the evidence on the basis of these studies suggests that teachers have generally understood their own activities within the framework of an empirical-inductivist view of science.

The reports of the results in these studies as already stated, appear almost invariably in the form of global scores e.g. 6.7 on S.L.C. [69] test. The interpretation of such results, beyond the above general remark that they tend to present an inductivist image of science (with the exception of TOUS), is very difficult due to the lack of a coherent basis for their construction, as Munby [106] observes. Nonetheless, it could be argued that they can be used for comparative purposes, provided that the same instrument is employed, since correlation of results obtained by different instruments are weak [107]. In this respect it is found that exposure to courses which pay attention to the philosophical basis of scientific knowledge enhances generally speaking the awareness regarding such issues [108].

Even these conclusions however are subject to Lucas' question "what does it mean for two groups to have the same TOUS score?" [109] which seems at least to be far more meaningful than Aikenhead's "what does it mean for one group to have an average TOUS score 4.27 points greater than another?" [110]. For, large differences in the interpretation of the nature of the scientific enterprise obscured by global scores are apparent and the seeming homogeneity could be misleading. Thus, Aikenhead's plea for more than "quantitative data elegantly manipulated by sophisticated statistics" [111] is reinforced.

There are four recent studies (tables T6.5 and T6.8) belonging to the second group of studies (more than one position included) and dealing with the exploration of teachers' views, namely those by Dibbs [58], Ogunniyi [64], Ogunniyi and Pella [66] and Rowell and Cawthron [67]. According to Dibbs [58] four types of science teacher could be discerned: the inductivist teacher (I), the verificationist teacher (V), the hypothetico-deductive teacher (H), and the teacher with mixed (no discernible) beliefs about the nature of science (O) [in this thesis (section III.2) it is argued that verification is a constituent component of inductivism]. On the question of which of these positions is the predominant one, Rowell and Cawthron [112] argue that one has to distinguish between teachers' views regarding science "as it is" on the one hand and "as it should be" on the other. On the first level, according to this study, there seem to be an "apparent confusion of Popperian and inductive-empiricist viewpoints" while "data appear more separated by respondents" on the second level. Apart from this however and in accordance with the above mentioned findings by Dibbs it is indicated that the "Kuhnian debate" has had relatively little impact. Finally, Ogunniyi [64], Ogunniyi and Pella [66] report results showing teachers leaning more to Hempel's thought [113] (a system arguably akin to empiricism-logical positivism).

These examples illustrate the point argued previously, namely that had other stances been included in various studies, it is not certain that their results would have been the same.

In conclusion it would seem that Munby's demand is quite appropriate [114] when asking for "rigorous, disciplined and logically consistent work" in disentangling conflicting models of science as a necessary prerequisite of the construction of any instrument of this type.

VI.4.2 Normative studies.

At this point the distinction (section VI.2) between those normative studies which advocate the relevance of philosophical considerations to the teaching of science and those which argue for the application of a particular philosophical system (e.g. Kuhnian) to aspect(s) of science education should be recalled. A discussion of the relevance of a philosophical analysis of scientific knowledge to science education which draws upon the relevant studies is given in section I.1. For this reason, only a brief outline of the conclusions of these studies will be presented here.

Referring to these studies, generally the message which comes across is that an analysis of scientific knowledge along philosophical lines is highly pertinent to a number of aspects (teachers' views, curricular design, school science textbooks) regarding the teaching of science at school level. Pioneering in this respect are the papers by J.T.

Robinson [23] and [24], Scheffler [114] not to mention Piaget who takes this line in "Psychology and Epistemology" [116] although in a more general perspective than strictly speaking that of science education.

In so far as the application of a certain model (view) of science is concerned, again in general terms, there seems to exist a consensus on the need to move away from the until recently prevailing empirico-inductivist model [117] so as to keep in pace with developments in epistemology [118].

It is here that the suggestions offered diverge. The majority of these papers propose either hypothetico-deductivism (Popperian version) or contextualism (indeed, the second version of contextualism in the terminology adopted in this thesis) as the appropriate models, whilst relativism - as argued for, by Feyerabend - receives scant support. The specific position(s) advocated by each of the studies under review are indicated in table T6.7.

VI.5 The dimensions of this study.

As already stated the main objective of this chapter is to locate this thesis in terms of the work done previously in the field. For this purpose the dimensions of the general framework proposed in section V.2 (table T5.1), as the set of distinctions in section VI.2 made it specific, will be applied.

The character of the present study is exploratory. The research instrument employed is a closed-ended questionnaire. For its construction the technique of systemic network analysis was employed to organise the preceding analysis of the relevant issues. Thus, a considerable analytical element is also present. Furthermore, applying the distinction between relevance and application, the study deals mainly with the aspects of application.

Its subject matter is the study of science teachers' views on certain philosophical issues pertaining to the theory of knowledge, some of their views concerning pedagogic discourse, and the contingent connections between these two areas. It should be stressed therefore, that the instrument is not intended to measure teachers' understanding of the issues involved.

As far as the scope of the study is concerned, it takes into account several positions in both the philosophical and the pedagogical domains. In philosophy, inductivism, hypothetico-deductivism, contextualism, relativism (level III philosophical systems), scientific realism, pragmatism, logical positivism (level II philosophical systems), realism, idealism, scepticism (level I philosophical systems) are considered (see chapter III). In pedagogy and curricular trends the "traditional" as opposed to a more "innovative" stance is the main distinction.

Lastly, it should be noted that the ontological question is one of the themes included in the philosophical component (level I and II philosophical systems). The justification for this distinction (i.e. between the ontological and epistemological level), its relevance, as well as its interpretative function have already been elaborated upon.

BIBLIOGRAPHICAL NOTES.

[1]. chapter V.

[2]. Ibid.

[3]. chapter III.

[4]. Butzow. J. W. and Linz, L. W. (1973).

[5]. Conant, J. B. (1947).

[6]. Connelly, F. M. (1969).

[7]. Connelly, F. M. (1971).

[8]. Elkana, Y. (1970).

[9]. Elkana, Y. (1975).

[10]. Fenstermacher, G. D. (1980).

[11]. Gardner, P. L. (1972).

[12]. Gardner, P. L. (1975).

[13]. Herron, M. D. (1969).

[14]. McMurrin, S. M. (1963).

[15]. Jones, D. M. (1974).

[16]. Ivany, J. W. G. (1969).

[17]. Lind, G. (1980).

[18]. Nadeau, R. and Desautels, J. (1984).

[19]. Nagel, E. (1969).

[20]. Phillips, D. C. (1974).

[21]. Price, K. (1973).

[22]. Roberts, D. A. and Russel, T. L. (1975).

[23]. Robinson, J. T. (1969a).

[24]. Robinson, J. T. (1969b).

[25]. Rogers, P. J. (1982).

[26]. Summers, M. K. (1982).

[27]. Tischer, R. P., Power, C. N. and Endean, L. (1972).

[28]. Abimbola, I. O. (1983).

[29]. Akeroyd, M. (1983a) and (1983b).

[30]. Cawthron, E. R. and Rowell, G. A. (1978).

[31]. Donnely, J. (1979).

[32]. Finley, F. N. (1983).

[33]. Forge, J. C. (1979).

[34]. Freundlich, Y. (1980).

[35]. Hamilton, N. I. (1974).

[36]. Heath, T. (1980).

[37]. Jones, V. J. (1981).

[38]. Knape, C. and Rosewell, P. T. (1980).

[39]. Laura, R. S. (1981).

[40]. Margetson, D. (1982).

[41]. Richardson, M. and Boyle, C. (1979).

[42]. Robinson, M. C. (1984).

[43]. Smolicz, J. J. and Nunan, E. E. (1975).

[44]. Steiner, H. J. (1980).

[45]. Swartz, R. (1982).

[46]. Tawney, D. A. (1974).

[47]. Wagner, P. A. (1983).

[48]. Whitaker, M. A. B. (1980).

[49]. Westwood, R. D. (1977).

[50]. Wright, P. F. (1982).

[51]. BSSC, (1963).

[52]. Behnke, F. L. (1968).

[53]. Bileh, V. Y. and Malik, M. H. (1977).

[54]. Brown, L. M. (1974).

[55]. Carrey, R. L. and Stauss, N. G. (1970).

[56]. Cooley, W. W. and Klopfer, L. (1961).

[57]. Crumb, G. H. (1965).

[58]. Dibbs, D. R. (1982).

[59]. Kimball, M. E. (1968).

[60]. Korth, W. W. (1969).

[61]. Mitias, R .G .E. (1970).

[62]. Moore, R. W. and Sutman, F. X. (1970).

[63]. Noll, V. H. (1935).

[64]. Ogunniyi, M. B. (1982).

[65]. Ogunniyi, M. B. and Pella, M. O. (1980).

[66]. Orsini-Romano, C. A. (1978).

[67]. Rowell, J. A. and Cawthron, E. R. (1982).

[68]. Schwirian, P. M. (1968).

[69]. S.L.C., (1967)

[70]. Stice, G. (1958).

[71]. Swan, M. (1966).

[72]. Tamir, P. (1972).

[73]. Welch, W. W. and Pella, M. O. (1968).

[74]. Wilson, J. M. (1977).

[75]. Zupp, R. R. (1974).

[76]. Aikenhead, G. S. (1973).

[77]. Doran, R. L., Guerin, R. O. and Cavalieri, J. (1974).

[78]. Durkee, G. P. (1974).

[79]. Hodson, D. (1985).

[80]. Jungwirth, E. (1970).

[81]. Lucas, A. M. (1975).

[82]. Mackay, L. D. (1971).

[83]. Munby, H. (1983).

[84]. Schmidt, D. J. (1968).

[85]. Trent, J. (1965).

[86]. Nock, D. A. and Nelson, R. W. (1982).

[87]. Dibbs, D. R. (1982), p. 211.

[88]. Lucas, A. M. (1975), p. 483.

[89]. Ibid., pp. 481-482.

[90]. Gardner, P. L. (1975).

[91]. Munby, H. (1975), p. 266.

[92]. Wilson, J. and Cowell, B. (1982).

[93]. Scheffler, I. (1973).

[94]. Hodson, D. (1985), pp. 28-29.

[95]. Margetson, D. (1982).

[96]. Solomon, J. (1983).

[97]. Driver, R. and Erickson, G. (1983).

[98]. Bruner, J. S. (1966).

[99]. Morrison A. and McIntyre D. (1973), p. 63.

[100]. Ibid., pp. 64-65.

[101]. Hodson, D. (1985), p.41.

[102]. Eggleston, J. F. (1975).

[103]. Margolis, J. (1984), ch. One.

[104]. Wetherick, N. E. (1979), pp. 91-109.

[105]. Gauld, C. F. and Hukins, A. A. (1980) p. 153.

[106]. Munby, H. (1983), pp. 147 and 158.

[107]. Doran, R. L., Guerin, R. O. and Cavalieri, J. (1974), pp. 325-326.

[108]. Hodson, D. (1985), p. 46, citing Weber, M. C. and Renner, J. W. (1972), Barnfield, J. P., Bethel, L. J. and Lamb, W. G. (1977), Bowyer, J. B. and Linn, M. C. (1978), Peterson, F. D. (1978) and finally Haukoos, G. D. and Penick J. E. (1983).

[109]. Lucas, A. M. (1975), p. 483.

[110]. Aikenhead, G. S. (1973), p. 546.

[111]. Ibid.

[112]. Rowell, J. A. and Cawthron, E. R. (1982), pp. 93-94.

[113]. Ogunniyi, M. B. (1982), pp. 28 and 30; Ogunniyi, M. B. and Pella, M. O. (1980), pp. 595-598.

[114]. Munby, H. (1983), p. 159.

[115]. Scheffler, I. (1973).

[116]. Piaget, J. (1972).

[117]. Smolicz, J. J. and Nunan, E. E. (1975), pp. 109, 123 and 125.

[118]. Ibid., pp. 102-104.

VII. THE RESEARCH INSTRUMENT.

This chapter presents the research instrument. The discussion is organised around:

-a description of the instrument (aims, content and scope);

-a discussion of certain problems related to this type (closed-ended) of instrument;

-the format of the instrument.

VII.1 Description of the instrument.

A. An outline of the aims and content.

The principal aim of the instrument can be seen as a means serving to identify and analyse teachers' assumptions in relation to:

a. philosophical dimensions of scientific knowledge;

b. certain aspects of the science curriculum;

c. certain aspects of the pedagogical theory.

It should be noted however, that the instrument was developed in such a way so as to make it possible to analyse respondents' views both in terms of the above areas treated as one entity and in terms of their constituent themes.

The entire instrument is presented in Appendix 1. It contains 94 statements and is organised in three components (philosophical, curricular and pedagogical). The constituent themes of each of these components are as follows:

1. Philosophical-epistemological component:
   a. scientific methodologies (13 statements),
   b. demarcation criteria (11 statements),

c. pattern(s) of scientific change (6 statements),

d. the status of scientific knowledge (5 statements),

e. the distinction between theory and observation in ontological terms (7 statements).

2. Curricular component:

a. the debate concerning the dichotomy specialised as opposed to integrated curriculum (10 statements),

b. the meaning of the terms content and process in science education (11 statements).

3. Pedagogical component:

a. assumptions about learning (9 statements),

b. assumptions about instruction (11 statements),

c. assumptions about certain aspects of classroom activities (11 statements).

Table T8.2 (section VIII.2) indicates which statement belong to which theme.

B. The scope of the instrument.

The decision to include several coherent philosophical, curricular, pedagogical positions in the instrument is of crucial importance for its design and construction. As previously argued (see section VI.4.1), it does not seem reasonable for an instrument which sets about to explore views to assume that only a particular position is the "correct" one, given the fact that consensus has not been established, let alone any definite "proof". It should be restated that this problem is different from either that of setting out to establish the extent to which a certain position has made an impact on teachers' views; or the extent to which teachers (or any other group) agree (or, disagree) with one particular system of thought; or to propose and defend a certain philosophical view.

The following table T7.1 brings together the information from chapter IV (in which the specific networks constructed to provide the basis for the development of the instrument are presented), showing the philosophical and psychological systems taken into account for the development of each theme.

Area	Theme	Positions
Philosophy Level I	Ontological question.	Realism Idealism Scepticism
Philosophy Level II	Observational and Theoretical entities distinction.	Sci. Realism Log. Positivism Pragmatism
Philosophy Level III	Scientific methodologies. Criteria of demarcation. Pattern(s) of scientific growth. Status of scientific knowledge.	(1),(2),(3),(4). (1),(2),(3),(4). (1),(2),(3),(4). (1),(2),(3),(4).
Curricular issues	Specialisation vs. Integrated Science	Specialised Curriculum. Integrated Curriculum.
Pedagogical issues	Assumptions about learning. Assumptions about instruction. Assumptions about aspects of clasroom activities.	(5),(6),(7). * *

Where (1): Inductivism. (2): Hypothetico-Deductivism. (3): Contextualism. (4): Relativism.
and (5): Cognitive theories. (6): Behaviourism. (7): Constructivism. * : Formation of empirical categories.

TABLE T7.1: The composition of the instrument.

Developing such an instrument, one has to confront the problem of reducing rather complicated arguments which represent the various philosophical and pedagogical stances in consideration, into simple statements.

This approach of reducing complicated arguments to single statements could be criticised, as introducing oversimplification, which could lead to a naive exposition of the respective positions. In section V.1 it is argued how the technique of systemic network analysis helps in this respect. In addition to this, the assumption is made that teachers' views on philosophical issues should not be compared, in so far as articulation and sophistication are concerned, with those of professional philosophers. One may note that this is far from assuming that teachers' views lack any "validity". It is to say however, that the level at which their views are operational is determined by, and oriented towards their task, which is obviously different from that of a professional in this field.

VII.2 Research assumptions and the type of the instrument.

The justification for the preference of a closed-ended instrument, the development of which is based on the systemic network analysis technique, has been argued in section V.1. Here, the focus will be on certain problematic aspects.

It has been mentioned [1] that one of the difficulties to be faced, when such instruments are used, could be seen in terms of assessing the level of interpretation the respondent attaches to the statements contained in the instrument.

With regard to this problem, it should be made clear that without a complementary procedure (e.g. in depth interviews), it is not possible to know the exact level of interpretation teachers employ, when responding to the instrument. However, given that teachers usually share many cultural elements (ranging from similar socio-cultural background [2], to similar stimuli from their working environment), it is not unreasonable to assume that the width of the spectrum of their interpretation of those statements would be sufficiently narrow so as not to pose serious problems regarding a comparison of their answers. Nevertheless, to limit this difficulty (Labaw [3], Berdie and Anderson [4], Oppenheim [5]), the use of emotionally loaded words, like wrong, correct, traditional, radical, etc. were practically excluded from the questionnaire.

Furthermore, Labaw [6] has identified the following further problematic aspects:

(1) the respondent may have never thought about the issues being raised by the question and therefore his answers will be completely uninformed or misinformed;

(2) the respondent may not care about the issues being raised by the question and therefore his answers may reflect salience rather than any concern or thought of his own;

(3) the answer categories provided by the researcher may not be adequate to allow the respondent a fair choice. Oppenheim [7] also stresses this point, arguing that it is one of the main sources of

introducing bias in the instrument.

There are some elements of communality between (1) and (2) above. They can be defended on the basis of empirical evidence which suggests that science teachers do care about issues related to philosophy - the studies referred to in table T6.2 indeed support this contention. A specific example here, is the studies conducted by Cawthron and Rowell [8] and Smolics and Nunan [9]. They have forcibly argued in their papers, that science lessons as well as the teaching material (e.g. textbook) convey and are underpinned by certain philosophical position(s). In addition to this, if one detects meaningful patterns in the responses to nearly 100 statements, it is rather difficult to sustain the position that random answers were given.

The third of the possible shortcomings (i.e. the question as to whether the instrument provides adequate "categories") could be seen as having two facets. Categories should be adequate both in terms of numbers (corresponding to diverse philosophical points) as well as in terms of introducing the right distinctions. Thus, a way of disentangling conceptually distinct, but interrelated systems is required. In this instrument, the categories provided arose from an a-priori analysis (chapter III) of the relevant issues and organised by a set of networks (chapter IV). What can be argued here is that this analysis, which is epitomised by the networks, is stated explicitly and is therefore open to critical discussion.

The meaning of the term "categories" requires clarification. A concrete example will serve this purpose:
A respondent is asked to choose one of the following alternatives to identify the different kinds of scientific enquiry:

1.there is basically one scientific method
2.there are different ways of being scientific" [10].

These two answers each constitute a distinct category.

If the respondent is not asked to choose between (1) and (2), but to answer the following questions in connection with both statements, namely,

(a) Do you agree or disagree with the statement?
(b) How sure do you feel about your reply (a)?

then clearly, the choices the respondent has are reflected in both the provided statements (1) and (2), as well as in the questions (a) and (b). What, however seems to be the decisive factor in terms of the provision of adequate categories is the extent to which statements (1) and (2) cover the intended ground. The above pair of questions (a) and (b) could be seen as a means, of enabling the respondent to express his/her opinions regarding each statement and furthermore to modify to a certain extent the clear cut positions, which the statements put forward. Clearly, the modification is meaningful only if the statements are not mutually exclusive and have covered, to a reasonable extent, all the possible ground.

Consider now for instance, the following alternatives:
In general, the better of two competing theories

(1) is the one which is nearest to the truth

(2) is the one which is the most useful

(3) is a matter of consensus amongst scientists arising out of critical scrutiny.

These cannot be seen as mutually exclusive: a respondent could for example hold that the better of two competing scientific theories is the one which is nearest to the truth and the consensus of the scientific community. In such a case, applying questions (a) and (b), the respondent would answer "agree" to alternative (1), "disagree" to alternative (2) and "agree" to alternative (3) - (qualifying each of his/her responses as "sure" or "unsure"). Thus, the respondent, in relation to these three alternatives could present his/her view clearly and with a reasonable degree of freedom of choice and flexibility.

With regard to the significance of the role of the statements (alternatives) as compared with that of the role of the pair of questions, which complement each statement, an analogy can be drawn. The statements can be seen to represent philosophical (or curricular, or pedagogical, as applicable) positions, so as to cover all the possible alternatives in the case of logically mutually exclusive statements, or to signal the extreme and some in-between points, in cases where the ground is conceived as a continuum. It should be noted that in the second case the statements are not mutually exclusive, nor do they cover the whole spectrum of alternatives, but rather cover the whole ground. In the former case the pair of questions (a) and (b), - which complement each statement - permit the researcher to elucidate the opinions of the respondent; whereas, in the latter, the questions, in addition to their previously mentioned function, could be seen as a vehicle which permits the respondent to move between the constant point provided by the statements, so to locate his/her views according to his/her choice.

It is therefore the statements themselves which are more significant in terms of setting boundaries, since the approach of joining each statement with a pair of questions as described above was adopted in this study, the term "categories" referring to the content of each of the statements.

VII.3 The format of the instrument.

The above attempt to clarify the meaning of the term categories has touched on the point of the "internal" structure of the statements. Consider the following two ways of presenting two statements which are the same in terms of content:

(A). The status of scientific knowledge

(1) is not different from that of any other kind of knowledge, all being of equal value.

(2) is different from other kinds of knowledge having a special value of its own.

or

(B). (1) Scientific knowledge is of special status because it has a special value of its own differing from other kinds of knowledge

(2) The status of scientific knowledge is not different from any other kind of knowledge, all being of equal value.

The first way of presentation (in which statements are comprised of stems and leafs) was chosen, mainly because it could help the respondent to place the statement in context (since it refers to other possible alternatives as well), thereby aiding the conceptualisation of the difference.

There are two other choices concerning the format of the instrument:

1. the use of a 1-4 scale and

2. the division of the instrument into three parts.

The first of these, which determines the scale of codification of the responses, refers to the kind of questions being asked. Here, the respondents were asked to answer two questions in connection with each statement in the questionnaire:

(a) Do you agree or disagree with the statement?

(b) How sure you feel about your reply (a)?

In so far as the question (a) is concerned the respondent had to choose between "agree or disagree", whilst in terms of question (b) the choice provided was between "sure" or "unsure".

This format was chosen because it was thought that it would be easier and in this sense more reliable for an individual to express his/her opinion in a qualitative way, instead of quantifying it.

The last aspect of the format concerns, as stated above, the division of the instrument into three parts. The first and the second of these used the above mode of questionning in relation to the respondents views. However, the first part contains statements which are obviously antithetical whilst in the second, simultaneous selection is possible.

The third part is different in this respect. A choice of one or more of the options is not only logically speaking possible, but also highly probable. A small scale pilot study verified this assumption. This however raises the problem of the discriminant power of this part of the instrument. For instance, it is difficult to disagree with any of the following statements [11]:

"It is essential to effective learning that account has been taken of

a. pupils' perception of their own needs.

b. pupils immediate prior knowledge.

c. pupils' ability to think at a sufficient level of abstraction."

One can reasonably argue here that the crucial element regarding teachers' views is not a matter of preferring one alternative at the expenses of another, but rather a matter of establishing the weight respondents attach to each alternative. For this reason teachers were asked here to put the alternatives for each statement in order of priority.

VII.4 Summarising the position.

The main characteristics of the instrument can be summarised in the following points:

1. The area of interest is to survey teachers' views about certain aspects of philosophy of scientific knowledge (on the ontological and epistemological levels) and certain curricular and pedagogical issues (specified in table T7.1).

2. The philosophical, curricular, pedagogical positions embedded in the instrument arose from an a-priori analysis. These positions are intented to cover the spectrum of currently prevailing trends in the respective areas.

3. The instrument is a closed-ended questionnaire and consists of three parts. In the first two parts agreement or disagreement with the statements is asked, while the third requires ordering of priority.

BIBLIOGRAPHICAL NOTES.

[1]. see section V.1.

[2]. Ozga, J. T. and Lawn, M. A. (1981), ch. 2.

[3]. Labaw, P. J. (1980).

[4]. Berdie, D. R. and Anderson, J. F. (1974).

[5]. Oppenheim, A. N. (1972).

[6]. Labaw, P. J. (1980), ch. 7.

[7]. Oppenheim, A. N. (1972).

[8]. Cawthron, E. R. and Rowell J. A. (1978).

[9]. Smolizs J. J. and Nunan E. E. (1975).

[10]. see section IV.4

[11]. see section II.2.1

VIII.1 THE EMPIRICAL ELEMENT: Outline of the strategy for analysis.

The empirical element of this piece of research deals with an analysis of teachers' philosophical, curricular and pedagogical views as they are expressed in relation to the teaching of science at the secondary level.

In this chapter an overall description and an analysis of the evidence gathered from the application of the questionnaire is given.

This analysis is organised in four stages:

a. The first stage presents the percentages of people who agree/or disagree with each statement, recording which statements show tendencies towards acceptance or rejection. Furthermore, attention is paid to the patterns of responses emerging from groups of statements which refer to the same theme (e.g. methodology of science, status of scientific knowledge, assumptions on learning, etc.). At this stage the focus is on the level of the whole sample as opposed to that of the individual. The intended outcome is an overall picture at the level of the whole sample, which consists of three components (philosophical, curricular, pedagogical).

b. In the second stage, there is a shift in focus from the level of the whole sample to that of individuals. Each statement (which could be seen as representing a variable), is combined with the answers of other statements belonging to the same theme, so as to illustrate the position of any given individual regarding this theme. Having done this, one can distinguish two groups of individuals: individuals with consistent views in terms of the background network and individuals with eclectic views in terms of the network. For those individuals who by having consistent views in terms of the network seem to accept the distinctions implied by the construction of the network, a map of their views regarding the three components (philosophical, curricular and pedagogical), can be constructed. On the other hand, an exploration of the correlations between the answers of those individuals who appear to have eclectic views in terms of the network, is attempted. Finally, the differentiation of opinions at subgroup level (PGCE students - teachers, physicists - chemists - biologists) is analysed.

c. The third stage can be seen as a continuation of the second. This stage deals with correlations between answers falling within different themes in the philosophical, curricular and pedagogical components, so as to lay a basis for a discussion on the sort of educational theory students and teachers hold.

d. In the final stage, an the attempt is made to bring elements from the three previous stages together and to draw out the conclusions (see chapter IX).

A schematic representation of this overall strategy for analysing the evidence gathered is shown in diagram D8.1. As indicated by this diagram, the structure-flow of analysis, as well as the discussion is informed by the background analysis (theoretical - substantive framework). Therefore, the acceptance of the specific points raised during the subsequent analysis and discussion is to a large extent conditional upon how one evaluates this background analysis.

Finally, before commencing the analysis proper and discussion of the data, a brief description of the sample and the assumptions on which the sampling is based as well as a reiteration of the structure of the instrument used is presented.

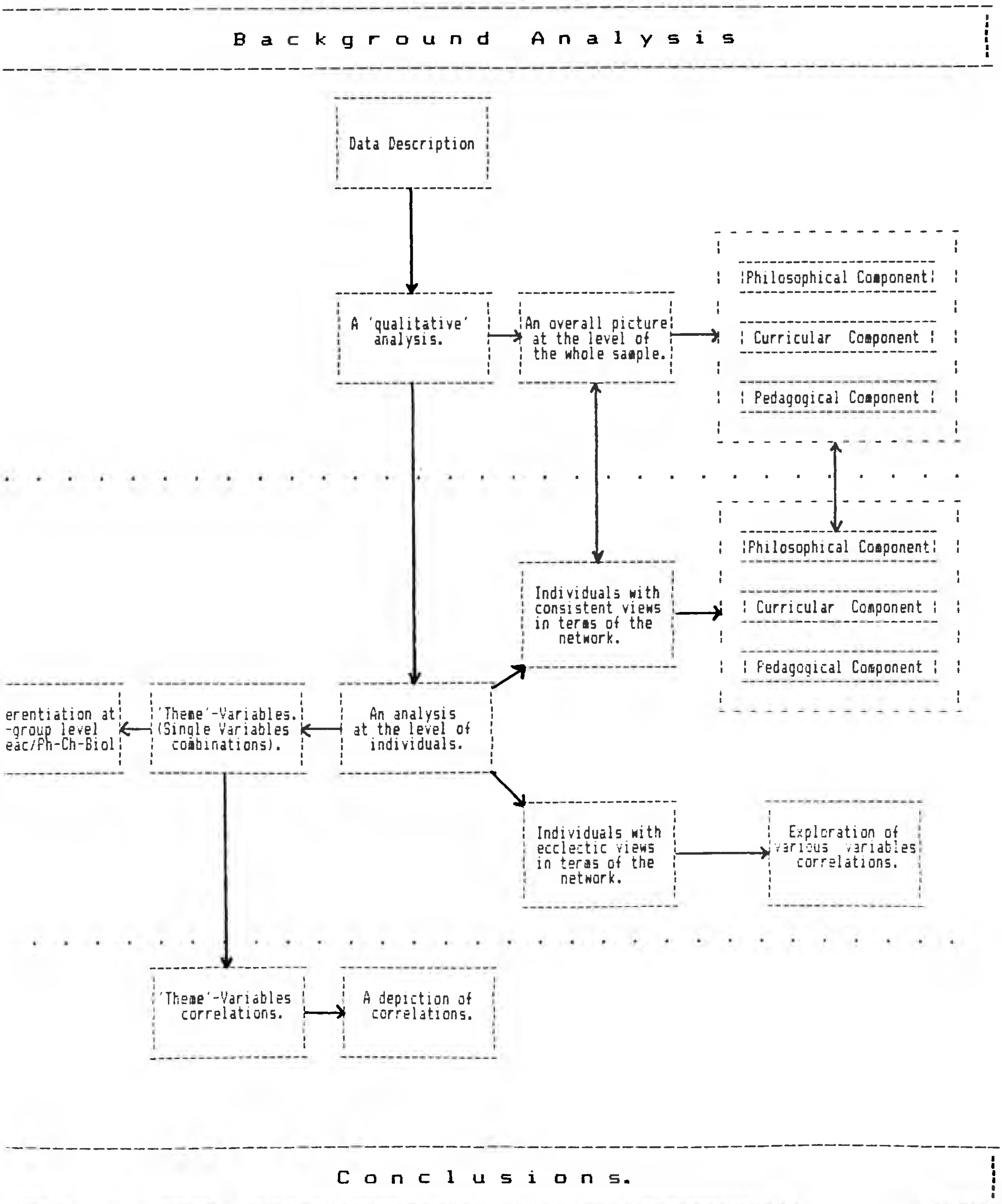


DIAGRAM D8.1: The stages of data analysis.

VIII.2 THE SAMPLE.

The target population from which the sample was drawn was young science teachers in urban schools and prospective science teachers (PGCE students). The sample comprised physics (male and female), chemistry (male and female) and biology (male and female) teachers and prospective teachers. Teachers were approached through the North and South London Science Centres. The cohort of the academic year 1984-1985 in the Science Education Dept. of ULIE constitutes the sample as far as the PGCE students are concerned. A detailed breakdown of the sample is given in table T8.1 below:

SAMPLE DESCRIPTION.

	Physics		Chemistry		Biology		S.-Total 1		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
Students	11	1	1	5	11	11	23	17	40
Teachers	12	3	14	6	7	12	33	21	54
S.-Total 2	27		26		41		94		
	23	4	15	11	18	23	56	38	94
									+1 geology student

									95

TABLE T8.1

It is hoped that by selecting for the sample people who have not expressed (e.g. by choice of attending a course) any special concern with philosophical-epistemological issues, that the views collected will be representative of "ordinary" teachers. Furthermore, the administration of the questionnaire was managed so as to avoid the possibility of self-selection by obtaining a response rate of nearly 100%.

VIII.3 THE INSTRUMENT.

Issues regarding the instrument are dealt with in chapter VII Here, a brief description of the structure and the thematic scope of the instrument is given, so to facilitate the unfolding of the subsequent analysis.

The questionnaire consists of three components which respectively address certain philosophical views of teachers, their views on curriculum and finally their views on pedagogy. Each of these components is constructed around certain themes, as follows:

COMPONENTS - THEMES - STATEMENTS OF THE INSTRUMENT.

THEMES.	STATEMENTS.
1. PHILOSOPHICAL-EPISTEMOLOGICAL COMPONENT.	
Sc. Methods	3a., 3b., 4a., 4b., 5a., 5b., 6a., 6b., 16a, 16b, 17a., 17b., 17c.
Criteria of Demarcation.	7a., 7b., 8a., 8b., 18a., 18b., 18c., 20a., 20b., 20c.
Pattern of sc. growth.	21a., 21b., 22a., 22b., 23a., 23b.
Ontological Question.	24a, 24b., 24c., 25a., 25b., 19., 18b.
Status of sc. Knowledge.	26a., 26b., 27a., 27b., 27c.
2. CURRICULAR COMPONENT.	
Content v. Process	2a., 2b., 9a., 9b., 9c., 29a., 29b., 29c., 30a., 30b., 30c.
Integrated Science	1a., 1b., 12a., 12b., 12c., 12d., 13a., 13b., 13c., 13d.
3. PEDAGOGICAL COMPONENT.	
Assumptions on Learning.	28a., 28b., 28c., 31a., 31b., 31c., 33a., 33b., 33c., (10a., 10b.)
Assumptions on Instruction.	14a., 14b., 14b., 15a., 15b., 32a., 32b., 34a., 34b., 34c., 34d.
Classroom practice.	35a., 35b., 35c., 35d., 35e., 36a., 36b., 36c., 36d.

TABLE T8.2: The composition of the themes.

The following data description and subsequent analysis is done separately for each of these components. Within each component the discussion of the responses, when their pattern is considered, is organised along the constituent themes of each component.

VIII.4 DESCRIPTIVE DATA ANALYSIS.

In this stage (see diagram D8.1) a description and a first elementary analysis of the evidence gathered is presented. There are two distinct intended outcomes:

-Firstly, to reveal the "dominant" pattern of responses at the level of the whole sample.

-Secondly, to check this pattern against all the possible positions (paths in the network), which the background analysis suggests (sections VIII.5.1 and VIII.5.2).

The first step of this stage (sections VIII.4.1, VIII.4.2 and VIII.4.3) presents initially the percentages of people who agree (or disagree) with each statement of the instrument, recording which statements show tendencies (towards acceptance or rejection of the idea expressed). These tendencies are subsequentl. employed in the treatment of the data so as to discern the "dominant" patterns of responses.

Instrumental in disentangling the tendencies is the following classification system.

TABLE INDICATING THE CATEGORIES FOR A FIRST CLASSIFICATION.

Boundaries.	Categories.
40%-60%	Relatively evenly divided.
30%-40% or 60%-70%	Clear tendency (either way).
15%-30% or 70%-85%	Strong tendency (either way).
less 15% or more 85%	Very strong tendency (either way).

TABLE T8.3

This "qualitative" treatment of the responses is helpful since it permits a first estimation of the dominant pattern. It should be stressed however that it is considered to be somewhat "rough" analysis, failing to take into account (even at the level of groups) other consistent patterns (positions) which co-exist besides the "dominant" one. The latter type of analysis will be discussed in the second stage (section VIII.6).

VIII.4.1 Descriptive analysis of the data: Philosophical component.

Below (table T8.4 and figure F8.1), the percentages of the respondents agreeing with each statement of the philosophical component of the instrument are presented. The nature of the items is described briefly for each; note however that an item is not an exhaustive test for a given position - for example, "realism" (statement 24a) means only a realist response to that question.

PHILOSOPHICAL-EPISTEMOLOGICAL COMPONENT.

Statements.	Total	Teach.	Stud.	Phys.	Chem.	Biol.	Male	Female
3a. Methodological unity.	29.8	42.6	12.5	11.1	36.0	39.0	21.1	43.2
3b. Methodological diversity.	Exact reverse picture.							
4a. Inductive reasoning.	68.8	71.7	65.0	55.6	92.0	62.5	67.3	71.1
4b. Deductive reasoning.	35.5	26.4	47.5	51.9	16.0	37.5	38.1	31.6
5a. Verification.	53.3	52.8	53.8	30.8	68.0	60.0	49.1	59.5
5b. Falsification.	48.9	45.3	53.8	76.9	32.0	40.0	56.4	37.8
6a. Existence of standards for the choice of sci. method.	82.6	82.7	82.5	92.3	83.3	75.6	80.4	86.1
6b. No standards for the choice of scientific method.	Exact reverse picture.							
7a. Existence of standards for considering a theory sci.	79.6	82.7	75.6	77.8	87.5	75.6	77.9	80.6
7b. No standards for considering a theory scientific.	Exact reverse picture.							
8a. Standards for the choice between sci. theories exist.	78.5	77.4	80.0	81.5	70.8	80.5	83.9	70.3
8b. No standards for the choice between scientific theories.	22.6	22.6	22.5	18.5	29.2	22.0	16.1	32.4
16a. Incompatible methods in science: Positive feature.	76.9	86.3	65.0	92.3	65.2	75.6	82.5	67.6
16b. Incompatible methods in science: Pointless to discuss methodology.	22.0	25.5	17.5	07.7	56.5	12.2	22.8	20.6
17a. Basis for choosing scientific method: "consensus".	64.5	67.9	60.0	57.7	57.7	75.0	57.1	75.7
17b. Basis for choosing sci. method: "embedded in science".	58.5	50.0	70.0	77.8	50.0	50.0	66.7	45.9
17c. Basis for choosing sci. method: "individual choice".	82.8	87.0	76.9	81.5	96.2	74.4	83.9	81.1
18a. Basis for choosing between sci. theories: "truth".	33.3	16.7	56.4	48.1	07.7	40.0	34.5	31.6
18b. Basis for choosing between sci. theories: "usefulness".	42.6	51.9	30.0	51.9	23.1	48.0	48.2	34.2
18c. Basis for choosing between sci. theories: "consensus".	86.2	92.6	77.5	85.2	96.2	80.5	85.7	86.8
19a. Proper sci. method essential for "truth" approximation.	41.9	42.6	41.0	40.7	34.6	46.2	42.9	40.5
20a. The search for demarc. crit. pointless: Knowl. frames.	57.0	56.6	59.0	37.0	61.5	67.0	42.9	78.4
20b. The search for demarc. criteria pointless: Ideology.	26.1	18.4	35.9	26.9	34.4	20.0	27.8	23.5
20c. The search for demarcation criteria fruitful.	65.6	71.7	56.8	69.2	73.1	57.9	73.6	54.1
21a. Characteristic of pattern of sc. change: Growth.	64.2	66.7	61.0	37.0	76.9	73.2	56.1	76.3
21b. Characteristic of pattern of sc. change: Change.	76.8	75.9	78.0	88.9	61.5	78.0	68.4	89.5
22a. Growth of knowledge: accumulation of facts.	93.6	94.4	92.5	96.3	96.2	90.0	91.2	97.3
22b. Growth of knowledge: succession of theories.	62.8	63.0	62.5	63.0	61.5	65.0	66.7	56.8
23a. New knowledge: Successive frameworks.	83.2	87.0	78.0	77.8	92.3	80.5	78.9	89.5
23b. New knowledge: No discernible pattern.	17.9	13.0	24.4	07.4	11.5	29.3	19.3	15.8
24a. Realism.	66.7	63.0	71.8	66.7	76.0	60.0	73.7	55.6
24b. Idealism.	30.9	31.5	30.0	37.0	12.0	39.0	24.6	40.5
24c. Scepticism.	21.1	22.2	19.5	11.1	23.0	28.8	26.3	13.2
25a. Scientific Realism.	02.1	00.0	04.9	03.7	03.8	00.0	01.8	02.6
25b. Logical Positivism.	83.2	79.6	87.8	81.5	96.2	75.6	87.7	76.3
26a. Scientific knowledge: Special status.	40.0	46.3	31.7	55.6	53.8	22.0	54.4	18.4
26b. Scientific knowledge: As any other form of knowledge.	67.0	69.8	63.4	37.0	80.0	80.5	53.6	86.8
27a. Basis for privil. position of sci. knowledge: Objective.	58.5	50.9	68.3	84.6	58.3	43.9	70.2	40.5
27b. Basis for privileged position of sci. knowledge: Useful.	65.5	61.1	70.7	74.1	76.9	53.7	64.9	65.8
27c. Basis for privil. position of sci. knowl.: Systematic.	68.4	68.5	68.3	81.5	80.8	51.2	71.9	63.2

TABLE T8.4

The following table T8.5a is a presentation of the accepted and rejected statements regarding the philosophical epistemological component.

STATEMENTS GENERALLY ACCEPTED.	STATEMENTS GENERALLY REJECTED.
3b. Methodological diversity.	3a. Methodological unity.
4a. Inductive reasoning.	4b. Deductive reasoning.
5a. Verification.	5b. Falsification.
6a. Standards for the choice of sc. method exist.	6b. No standards for the choice of scientific method.
7a. Existence of stand. for considering a theory sci.	7b. No standards for considering a theory scientific.
8a. Stand. for the choice between sc. theories exist.	8b. No standards for the choice between sc. theories.
16a. Incompatible meth. in sc.: Positive feature.	16b. Incomp. meth. in sc.: Pointless to discuss methodology.
17a. Basis for choosing sc. method: "consensus".	
17b. Basis for choosing sc. method: "embedded in science".	
17c. Basis for choosing sc. method: "individual choice".	
18c. Basis for choosing between theories: "consensus".	18a. Basis for choosing between theories: "truth".
	18b. Basis for choosing between sc. theories: "usefulness".
	19a. Proper sc. method essential for "truth" approximation.
20a. Frames of knowl: Search for demarc. criteria pointless.	20b. Sc. knowl.-ideology: The search for demarc. criteria pointless.
20c. The search for demarc. criteria could generally be fruitful.	
21a. Characteristic of pattern of sc. change: Growth.	
21b. Characteristic of pattern of sc. change: Change (not growth).	
22a. Growth of knowledge: accumulation of facts.	
22b. Growth of knowledge: succession of theories.	
23a. New knowledge: Successive frameworks.	23b. New knowledge: No discernible pattern.
24a. Realism.	24b. Idealism.
	24c. Scepticism.
25b. Scientific Realism.	25a. Logical Positivism.
26b. Sci. knowledge: As any other form of knowledge.	26a. Scientific knowledge: Special status.
27a. Basis for the unique position of sc. knowledge: Objective.	
27b. Basis for the unique position of sc. knowledge: Useful.	
27c. Basis for the unique position of sc. knowledge: Systematic.	

TABLE T8.5a: Accepted and rejected statements for the philosophical-epistemological component.

The next step is to try to reveal the tendencies emerging from the responses. Applying the classification boundaries (table T8.3) in the above table T8.4, these tendencies are as follows:

TENDENCIES IN THE RESPONSES: PHILOSOPHICAL - EPISTEMOLOGICAL COMPONENT.

Very Strong Tendency		Strong Tendency		Clear Tendency		Evenly Divided.	
Acc.	Rej.	Acc.	Rej.	Acc.	Rej.	Acc.	Rej.
18c.	25a.	3b.	3a.	4a.	4b.	5a.	5b.
22a.		6a.	6b.	17a.	18a.	17b.	18b.
		7a.	7b.	20c.	24b.	20a.	19.
		8a.	8b.	21a.	26a.	27a.	
		16a.	16b.	22b.			
		17c.	20b.	24a.			
		21b.	23b.	26b.			
		23a.	24c.	27b.			
		25b.		27c.			
----	----	----	----	----	----	----	----
2	1	9	8	9	4	4	3

Total: 40 Statements.

TABLE T8.5b

What follows is a reconstruction of the views of the respondents, which is based on the classification of the data shown in the above tables T8.5a and T8.5b. This reconstruction takes into account the combination of accepted and rejected statements for any idea-choice which exists in the instrument. For instance, with regard to the question of methodological unity or diversity in science, which is initially asked about by statements 3a and 3b, the responses seem to suggest that the population leans towards methodological diversity since generally statement 3b is accepted whilst statement 3a is rejected. There are however some cases, namely statements

-17a, 17b, 17c, (the basis for choosing between scientific methods if methodological diversity is the case);

-27a, 27b, 27c, (the justification for considering scientific knowledge unique if its special status is accepted);

-20a, 20c, (criteria of demarcation);

-21a, 21b, (characteristics of pattern of scientific change);

-22a, 22b, (growth of knowledge by accumulation of facts or succession of theories);

where more than one choice is being accepted. It is worth noting that in all these cases the instrument allows these co-selections.

For the purposes of this preliminary analysis the statement with the stronger tendency, as indicated by table T8.5b is selected. For example between 17a (accepted, clear tendency), 17b (accepted, evenly divided) and 17c (accepted, strong tendency), statement 17c (the choice of scientific method is a matter of individual standards) was selected.

Applying the above criteria, table T8.6 below shows the main broad pattern of the responses.

RESPONDENTS' VIEW ON PHILOSOPHICAL-EPISTEMOLOGICAL ISSUES.

Group of statements	Central notion.	Expressed choice.
3a., 3b.	Methodological issues.	3b. Methodological diversity.
4a., 4b.	Inductive v. Deductive reasoning	4a. Inductive reasoning.
5a., 5b.	Verification v. Falsification.	5a. Verification.
6a., 6b.	Standards for sc. method.	6a. Existence of "rational" standards.
7a., 7b.	Standards for theory "scientific".	7a. Existence of "rational" standards.
8a., 8b.	Standards for choice between theories.	8a. Existence of "rational" standards.
16a., 16b.	Posit. or negat., if diversity.	16a. Incompatible meth. in science: Positive feature.
17a., 17b., 17c.	Basis for choosing scientific method.	17c. Basis for choice: individual choice, "consensus".
18a., 18b.. 18c.	Basis for choosing scientific theories.	18c. Choice based on "consensus".
20a., 20b., 20c.	Criteria of demarcation.	20c. The search for demarc. crit. could be fruitful.
21a., 21b.	Change v. Growth in science.	21b. Characteristic of pattern of change: No growth.
22a., 22b.	If growth: Facts or theories.	22a. Growth of knowledge: accumulation of facts.
23a., 23b.	Succesive frameworks v. no pattern.	23a. New knowledge: Successive frameworks.
24a., 24b., 24c.	Realism, Idealilism, Scepticism.	24a. Realism.
25a., 25b.	Sci. Realism, Log. Positivism.	25b. Scientific Realism.
26a., 26b.	Sc. knowledge: Special or as other.	26b. Sci. knowledge: As any other form of knowledge.
27a., 27b., 27c.	On what basis, if special.	27b. and 27c. Privileged pos. of sc. knowledge: Useful, systematic.

TABLE T8.6

It is thus possible to summarise the view taken by the respondents, (table T8.6) in the following points:

1. It is a positive feature of science that methodological diversity exists; diversity which conforms to rational standards for choosing between scientific methods. Individuals use their own criteria for such a choice.

2. Criteria of demarcation for scientific theories have built-in rational standards.

3. Science changes through successive frameworks of knowledge. Essential to this is the accumulation of "facts".

4. Scientific knowledge is not privileged vis-a vis other forms of knowledge but it is a useful and systematic pattern of thought.

5. As far the ontological issue is concerned realism is the overwhelming choice.

What tables T8.4, T8.5a and T8.5b are indicating can be seen in the following figure F8.1, in which the percentages of the respondents who agree with each statement of this component are given. Furthermore, in this figure the areas where a tendency (as well as the strength of tendency) exists is shown.

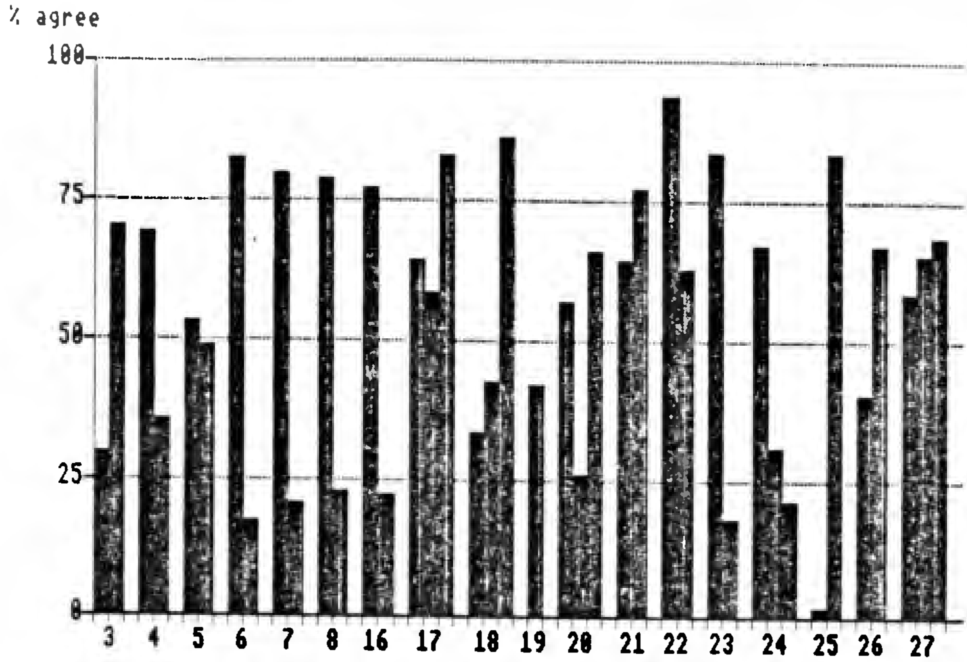


FIGURE F8.1: Philosophical component.

VIII.4.2 Descriptive analysis of the data: Curricular component.

As for the philosophical - epistemological component, the percentages of the respondents agreeing with each of the statements of the curricular component of the instrument are presented below.

C U R R I C U L A R   C O M P O N E N T.

Statements.	Total	Teach.	Stud.	Phys.	Chem.	Biol.	Male	Female
1a. Teaching of separate scientific subjects.	40.0	44.4	34.1	33.3	46.2	41.5	47.4	28.9
1b. Teaching of integrated sience.	Exact reverse picture.							
2a. Scientific content and process are distinct.	26.3	27.8	24.4	51.9	15.4	17.1	40.4	05.3
2b. Scientific content and process are strongly related.	78.9	74.1	85.4	63.0	88.5	82.9	64.8	94.7
9a. Teaching of science: Emphasis on the content.	10.5	13.0	07.3	18.5	00.0	10.2	10.5	10.5
9b. Teaching of science: Emphasis on the process.	28.7	29.6	27.5	48.1	19.2	22.5	28.6	28.9
9c. Sc. content and process: No difference in emphasis.	93.7	92.6	95.1	96.3	88.5	95.1	93.0	94.7
10a. Teaching of science in a historical perspective.	83.2	83.3	82.9	85.2	76.9	85.4	75.4	94.7
10b. Teaching of science as currently understood.	57.3	40.7	70.7	59.3	42.3	58.5	50.9	57.9
11a. Emphasis on the similarities of sc. subjects.	20.0	16.7	24.4	22.2	30.8	10.2	21.1	18.4
11b. Emphasis on the differences of sc. subjects.	94.7	94.4	95.1	96.3	88.5	97.6	93.0	97.4
10a. Argument for separate subjects: Diff. in content.	62.8	56.6	70.7	55.6	52.0	75.0	55.4	73.7
10b. Argument for separate subjects: Diff. in process.	28.7	17.0	43.9	33.3	24.0	29.3	30.4	26.3
10c. Argument for separate subjects: Practical reasons.	52.1	62.3	39.0	51.9	52.0	53.7	50.0	55.3
10d. Argument for separate subjects: Academic standards.	19.1	17.0	22.0	18.5	20.0	19.5	17.9	21.1
13a. Argument for integrated science: Unity of concepts.	77.7	69.8	87.8	70.4	72.0	85.4	73.2	84.2
13b. Argument for integrated science: Unity of methods.	69.9	75.5	62.5	66.7	64.0	75.0	69.1	71.1
13c. Argument for integrated science: Practical reasons.	30.9	34.0	26.8	51.9	08.0	31.7	30.4	31.6
13d. Argument for integrated science: Social relevance.	88.2	83.0	95.0	74.1	100	90.0	81.8	97.4
29a. Scientific content: Sc. theories and laws.								
High preference.	07.5	05.7	10.0	18.5	00.0	04.9	08.8	05.6
Middle choice.	17.2	11.3	25.0	14.8	25.0	14.6	14.0	22.
Low preference.	75.3	83.0	65.0	66.7	75.0	80.0	77.2	72.2
29b. Scientific content: Experimental and observational data.								
High preference.	36.0	37.7	35.0	22.2	61.5	29.3	38.6	33.3
Middle choice.	53.8	60.4	45.0	59.3	30.3	63.4	54.4	52.8
Low preference.	09.7	01.9	20.0	18.5	04.2	07.3	07.0	19.3
29c. Scientific content: Experimental and observational techniques.								
High preference.	55.9	56.6	55.0	59.3	37.5	65.9	52.6	61.1
Middle choice.	29.0	28.3	30.0	25.9	41.7	22.0	31.6	25.0
Low preference.	15.1	15.1	15.0	18.4	20.8	10.2	15.8	13.9
30a. Scientific process: Scientific methods (how to be scientific).								
High preference.	39.0	28.0	55.0	59.3	25.0	36.6	36.8	44.4
Middle choice.	21.5	22.6	20.0	07.4	29.2	24.4	10.3	36.1
Low preference.	38.7	49.1	25.0	33.3	45.8	39.0	50.9	19.4
30b. Scientific process: Handling of experimental and observational data.								
High preference.	21.5	20.8	22.5	25.9	33.3	09.8	29.8	08.3
Middle choice.	45.2	54.7	32.5	63.0	45.8	34.1	50.9	36.1
Low preference.	33.3	24.5	45.0	11.1	20.8	56.1	19.3	55.6
30c. Scientific process: How to devise experiments.								
High preference.	38.7	50.9	22.5	14.8	27.8	53.7	33.3	47.2
Middle choice.	33.3	22.6	47.5	29.6	25.0	41.5	36.8	27.8
Low preference.	28.0	26.4	30.0	55.6	33.3	04.9	29.8	25.0

TABLE T8.7

The following table T8.8a is a presentation of the generally accepted and rejected statements regarding the curricular component.

STATEMENTS GENERALLY ACCEPTED.	STATEMENTS GENERALLY REJECTED.
1b. Teaching of integrated science.	1a. Teaching of separate scientific subjects.
2b. Scientific content and process are related.	2a. Scientific content and process are distinct.
9c. Sc. content and process: No difference in emphasis.	9a. Emphasis on the content.
	9b. Emphasis on the process.
10a. Teaching of science in a historical perspective.	
10b. Teaching of science as currently understood.	
11b. Emphasis on the differ. of sc. subjects.	11a. Emphasis on the simil. of sc. subjects.
12a. Arguement for separate subj.: Differ. in content.	12b. Arguement for separate subj.: Differ. in process.
12c. Arguement for separate subj.: Practical reasons.	12d. Arguement for separate subj.: Academic standards.
13a. Arguement for integrated sc.: Unity of concepts.	13c. Arguement for integrated sc.: Practical reasons.
13b. Arguement for integrated sc.: Unity of methods.	
13d. Arguement for integrated sc.: Social relevance.	

TABLE T8.8a

Not all the statements have the same format in this component. Specifically, for the statements 29a, 29b, 29c, 30a, 30b and 30c indication of preference was asked for rather than acceptance or rejection. The preferences given, according to table T8.7, appear in table T8.8b below.

TABLE INDICATING THE PREFERENCES: CURRICULAR COMPONENT.

High preference.	Middle choice.	Low preference.
29c.	29b.	29a.
30a.	30c.	30b.

TABLE T8.8b

As before (philosophical-epistemological component in section VIII.4.1), that is to say applying the same criteria, the tendencies emerging are shown below (table T8.8c).

TENDENCIES IN THE RESPONSES: CURRICULAR COMPONENT.

Very Strong Tendency		Strong Tendency		Clear Tendency		Evenly Divided.	
Acc.	Rej.	Acc.	Rej.	Acc.	Rej.	Acc.	Rej.
9c.	9a.	2b.	2a.	1b.	1a.	10b.	
11b.	11a.	9a.	9b.	12a.	13c.	12c.	
13d.	29a.	13a.	11a.	13b.	29b.	29c.	
			12b.		30a.		
			12d.		30c.		
			30c.				
3	3	3	6	2	5	3	0

Total: 25 Statements.

TABLE T8.8c

The following figure F8.2 displays in the form of a bar-chart the percentages of people who agree with each statement.

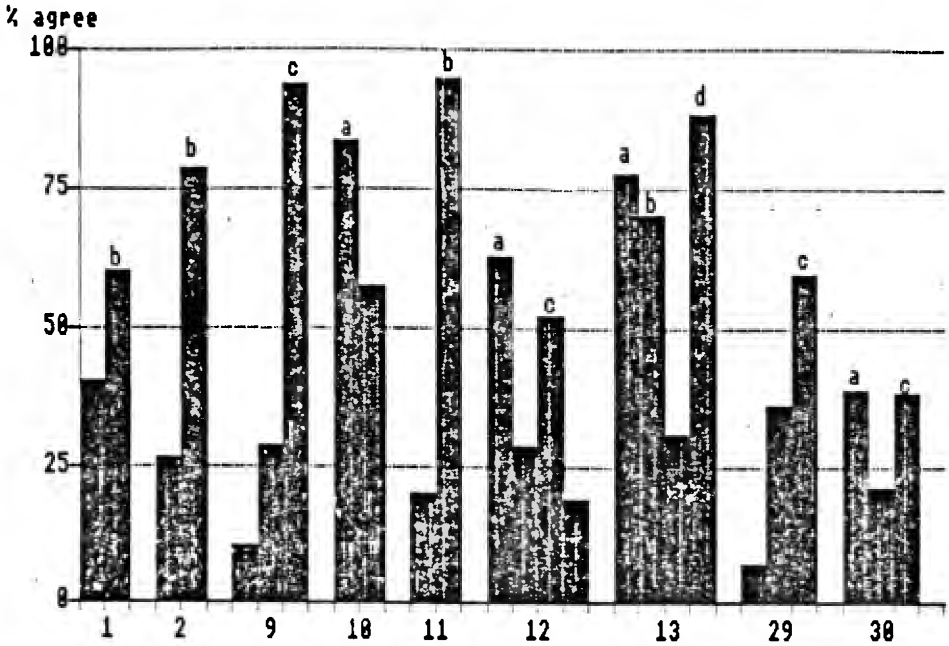


FIGURE F8.2: Curricular component.

Taking into account tables T8.8a, T8.8b (as a source) and T8.8c (criterion as in the philosophical component) one can proceed in the disentaglement of the dominant view expressed by the respondents regarding the questions of science curriculum.

RESPONDENTS' VIEW OF CURRICULAR ISSUES.

Group of statements.	Central notion.	Expressed choice.
1a., 1b.	Integrated science v. separate subjects	1b. Teaching of integrated science.
2a., 2b.	Sc. content and process.	2b. Scientific content and process are related.
9a., 9b., 9c.	Emphasis on teaching: Content v. Process.	9c. No difference in emphasis.
10a., 10b.	Sc. in hist. context or current understand.	10a.,10b. Both
11a., 11b.	Emphasis on diff. or simil. of sc. subjects.	11b. Emphasis on the differences of sc. subjects.
12a.,12b.,12c.,12d.	Arguments for separ. subjects.	12a. Argument for separ. subj.: Diff. in content.
13a.,13b.,13c.,13d.	Arguments for integr. science.	13a.,13b.,13d. Unity of concepts and methods; Social relevance.
29a., 29b., 29c.	Meaning of sc. content.	29c. Experimental and observational techniques.
30a., 30b., 30c.	Meaning of sc. process.	30a. Scientific methods.

TABLE T8.9

Summarising, this preliminary analysis of the responses seems to suggest that:

a. Teaching of integrated science is favoured mainly because of a postulated unity of concepts coupled with the perception that this could help to make the teaching of science socially relevant. However attention should also be paid to the differences between the scientific subjects.

b. Content and process in science are thought to be strongly related; by content is meant mainly observational and experimental techniques whilst process is seen as having a connection with methodological issues.

VIII.4.3 Descriptive analysis of the data: Pedagogical component.

Table T8.10 presents the percentages of the teachers who agreed with each statement of the pedagogical component of the instrument.

PEDAGOGICAL COMPONENT.

Statements.	Total	Teach.	Stud.	Phys.	Chem.	Biol.	Male	Female
14a. Reinforcement: Integral part of instruction.	74.4	70.4	80.5	66.7	57.7	90.2	71.9	78.9
14b. Reinforcement: Occasional use.	63.8	59.3	70.0	77.8	57.7	57.5	67.9	57.9
14c. Reinforcement: Irrelevant to instruction.	08.4	07.4	09.8	07.4	15.4	04.9	05.3	13.2
15a. Effective teaching: objectives oriented.	78.9	75.9	82.9	81.5	69.2	85.4	71.9	89.5
15b. Effective teaching: Teachers centred.	97.9	100	95.1	92.6	100	100	96.5	100
28a. Aims of learning: Rational understanding of the subject.								
High preference.	58.1	55.8	61.0	51.9	75.5	51.2	51.8	67.6
Middle choice.	21.5	23.1	19.5	22.2	08.3	29.3	26.8	13.5
Low preference.	20.4	21.2	19.5	25.9	16.7	19.5	21.4	18.9
28b. Aims of learning: Knowledge and skills of the subject.								
High preference.	24.7	32.7	14.6	25.9	12.5	31.7	26.8	21.6
Middle choice.	23.7	11.5	39.0	33.3	20.8	19.5	21.4	27.0
Low preference.	51.6	55.8	46.3	40.7	66.7	48.8	51.8	51.4
28c. Aims of learning: Individual view of the subject.								
High preference.	17.1	11.5	24.4	22.2	12.5	17.1	21.4	10.8
Middle choice.	54.8	65.4	41.5	44.4	70.8	51.2	51.8	59.5
Low preference.	28.0	23.1	34.1	33.3	16.7	31.7	26.8	29.7
31a. Assessment of learning outcome: Check of what pupils can be seen to do.								
High preference.	28.7	32.1	24.4	37.0	32.0	22.0	28.1	29.7
Middle choice.	22.3	05.7	43.9	25.9	12.0	26.8	28.1	13.5
Low preference.	48.9	62.3	31.7	37.0	56.0	51.2	43.9	56.8
31b. Assessment of learning outcome: Acquisition of the concepts of the subject.								
High preference.	35.1	26.4	46.3	29.6	40.0	36.6	40.4	27.0
Middle choice.	54.3	73.6	29.3	63.0	60.0	43.9	49.1	62.2
Low preference.	10.6	00.0	24.4	07.4	00.0	10.5	10.5	10.8
31c. Assessment of learning outcome: Pupils' own self assessment.								
High preference.	36.2	41.5	29.3	33.3	28.0	41.5	31.6	43.2
Middle choice.	23.4	20.8	26.8	11.1	28.0	29.3	22.8	24.3
Low preference.	40.4	37.7	43.9	55.6	44.0	29.3	45.6	32.4
32a. Presentation of knowledge: Small steps.								
High preference.	68.1	83.0	48.8	44.4	84.0	73.2	66.7	70.3
Middle choice.	31.9	17.0	51.2	55.6	16.0	28.6	33.3	29.7
32b. Presentation of knowledge: The whole idea first.								
High preference.	31.9	17.0	51.2	56.6	16.0	26.8	33.3	29.7
Middle choice.	68.1	83.0	48.8	44.4	84.0	73.2	66.7	70.3
33a. Prerequisite for efficient learning: self perception of needs.								
High preference.	29.8	34.0	24.4	55.6	24.0	17.1	38.6	16.2
Middle choice.	27.7	32.1	22.0	03.7	36.0	36.6	29.8	24.3
Low preference.	42.6	34.0	53.7	40.7	40.0	46.3	31.6	59.5

33b. Prerequisite for efficient learning: Prior knowledge of subject.							
High preference.	30.9	22.6	41.5	22.2	40.0	29.3	35.1	24.3
Middle choice.	38.3	39.6	36.6	48.1	36.0	34.1	36.8	40.5
Low preference.	30.9	37.7	32.0	29.6	24.0	36.6	28.1	35.1
33c. Prerequisite for efficient learning: Ability for abstract thought.							
High preference.	39.4	43.4	34.1	22.2	36.0	53.7	26.3	59.5
Middle choice.	34.0	28.3	41.5	48.1	28.0	29.3	33.3	35.1
Low preference.	26.6	28.3	24.4	29.6	36.0	17.1	40.4	05.4
34a. Crucial element for motivation: Active participation.							
High preference.	60.2	63.5	56.1	44.4	83.3	56.1	64.3	54.1
Middle choice.	36.6	36.5	36.6	51.9	16.7	39.0	32.1	43.2
Low preference.	03.2	00.0	07.3	03.7	00.0	04.9	03.6	02.7
34b. Crucial element for motivation: Enjoyment of subject.							
High preference.	30.1	36.5	22.0	44.4	16.7	29.3	25.0	37.0
Middle choice.	68.8	63.5	75.6	51.9	83.3	70.7	73.2	62.5
Low preference.	01.1	00.0	02.4	03.7	00.0	00.0	01.8	00.0
34c. Crucial element for motivation: Like the teacher.							
High preference.	05.4	00.0	12.2	03.7	00.0	09.8	05.4	05.4
Middle choice.	46.2	42.3	51.2	48.1	45.8	43.9	42.9	51.4
Low preference.	48.4	57.5	36.6	48.1	54.2	46.3	51.8	43.2
34d. Crucial element for motivation: Respect teacher.							
High preference.	03.2	00.0	07.3	07.4	00.0	02.4	05.4	00.0
Middle choice.	84.9	86.5	82.9	85.2	100	78.0	91.1	75.7
Low preference.	11.8	13.5	09.8	07.4	00.0	19.5	03.6	24.3
34e. Crucial element for motivation: Successful feedback.							
High preference.	01.1	00.0	02.4	00.0	00.0	02.4	00.0	02.7
Middle choice.	63.4	71.2	53.7	63.0	54.2	68.3	60.7	67.6
Low preference.	35.5	28.8	43.9	37.0	45.8	29.3	39.3	29.7
35a. Essential characteristic of a "good" lesson: Clear explanation by teacher.							
High preference.	28.7	41.5	12.2	40.7	00.0	39.0	21.1	40.5
Middle choice.	25.5	17.0	36.6	18.5	44.0	19.5	29.8	18.9
Low preference.	45.7	41.5	51.2	40.7	56.0	41.5	49.1	40.5
35b. Essential characteristic of a "good" lesson: Pupils' investigations.							
High preference.	13.8	11.3	17.1	18.5	16.0	07.3	17.5	08.1
Middle choice.	44.7	41.5	48.8	44.4	44.0	46.3	45.6	43.2
Low preference.	41.5	47.2	34.1	37.0	40.0	46.3	36.8	48.6
35c. Essential characteristic of a "good" lesson: Guided discovery.							
High preference.	46.8	47.2	46.3	33.3	72.0	41.5	56.1	32.4
Middle choice.	50.0	52.8	46.3	63.0	24.0	56.1	40.4	64.9
Low preference.	03.2	00.0	07.3	03.7	04.0	02.4	03.5	02.7
35d. Essential characteristic of a "good" lesson: Active discussion.							
High preference.	10.6	00.0	24.4	07.4	12.0	12.2	55.3	18.9
Middle choice.	79.8	87.7	68.3	74.1	88.0	78.0	84.2	73.0
Low preference.	09.6	11.3	07.3	18.5	00.0	09.8	10.5	08.1
36a. Attributes of effective teacher: Knowledge of the subject.							
High preference.	29.0	32.1	25.0	33.3	48.0	14.6	30.3	21.6
Middle choice.	32.3	30.2	35.0	37.0	24.0	34.1	30.4	35.1
Low preference.	38.7	37.7	40.0	29.6	28.0	52.1	35.7	43.2
36b. Attributes of effective teacher: Understanding of pupils.							
High preference.	36.6	34.0	40.0	33.3	04.0	58.5	28.6	48.6
Middle choice.	60.2	66.0	52.5	63.0	92.0	39.0	67.9	48.6
Low preference.	03.2	00.0	07.5	03.7	04.0	02.4	03.6	02.7
36c. Attributes of effective teacher: Effective teaching techiques.							
High preference.	26.9	28.3	25.0	25.9	32.0	24.4	32.1	18.9
Middle choice.	67.7	71.7	62.5	66.7	64.0	70.7	64.3	73.0
Low preference.	05.4	00.0	12.5	07.4	04.0	04.9	03.6	08.1
36d. Attributes of effective teacher: Respect pupils.							
High preference.	07.5	05.7	10.0	07.4	16.0	02.4	05.4	10.8
Middle choice.	39.8	32.1	50.0	33.3	20.0	56.1	37.5	43.2
Low preference.	52.7	62.3	40.0	59.3	64.0	41.5	57.1	45.9

TABLE T8.10

The statements included in this component have a different format than those of the two previous components. For this reason in this case it is not helpful to speak of acceptance or rejection of a particular statement but it is rather a matter of relative preference. Taking this into account, the tendencies which emerged, regarding this component are indicated in the following table T8.11.

TABLE INDICATING THE PREFERENCES: PEDAGOGICAL COMPONENT.

High preference.	Middle choice..	Low preference.
28a.	28b.	28c.
31c.	31b.	31a.
32a.		32b.
33c.	33b.	33a.
34a.	34b., 34c., 34d.	34e.
35c.	35a., 35b.	35d.
36b.	36a., 36c.	36d.

TABLE T8.11a

With regard to the five statements (14a, 14b, 14c, 15a and 15b) belonging to this component, for which agreement or disagreement was required, the picture is as follows:

TENDENCIES IN THE RESPONSES: PEDAGOGICAL COMPONENT.

Very Strong Tendency		Strong Tendency		Clear Tendency		Evenly Divided.	
Acc.	Rej.	Acc.	Rej.	Acc.	Rej.	Acc.	Rej.
15b.	14c.	14a. 15a.		14b.			

TABLE T8.11b

The overall situation for this component is depicted in the following figure F8.3.

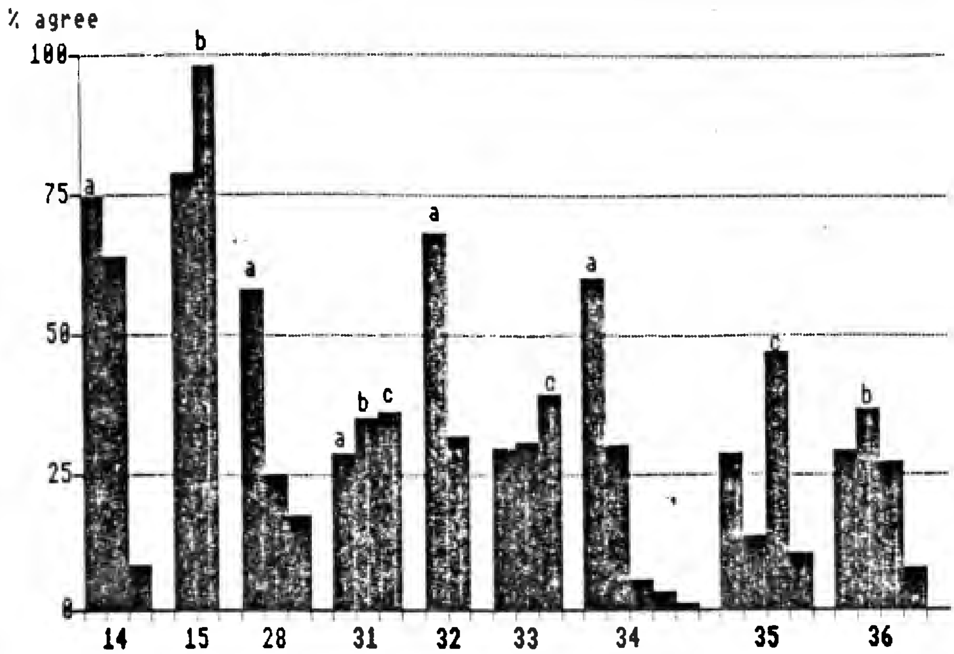


FIGURE F8.3: Pedagogical component.

From the tables T8.11a and T8.11b, applying the same criteria as for the two previous components in order to ravel the teachers dominant views. for the pedagogical questions encompassed in the instrument, the following table T8.12 was constructed.

RESPONDENTS' VIEW ON PEDAGOGICAL ISSUES.

Group of statements.	Central notion.	Expressed choice.
14a.,14b.,14c.	Role of reinforcement.	14a. Reinforcement: Integral part of instruction
15a.,15b.	Objectives or teacher-centred teaching.	15b. Teacher-centred.
28a.,28b.,28c.	Aims of Learning.	28a. Rational understanding of the subject.
31a.,31b.,31c.	Assessment of learning outcome.	31c. Pupils' own self assessment.
32a,32b.	Presentation of knowledge.	32a. In small steps.
33a.,33b.,33c.	Prerequisite for efficient learning.	33c. Pupils' ability for abstract thought.
34a.,34b.,34c.,34d.,34e.	Crucial element for motivation.	34a. Pupils active participation.
35a.,35b.,35c.,35d.	Characteristic of a "good" lesson.	35c. Guided discovery.
36a.,36b.,36c.,36d.	Attributes of effective teacher.	36b. Understanding of pupils.

TABLE T8.12

Interpreting the above table T8.12, it could be argued that the following points are central to teachers views.

1. Learning.

Learning should aim at a rational understanding of the subject and an essential prerequisite of successful learning is pupils' ability to think in abstract terms. The assessment of learning outcome should be judged in terms of pupils' self-perception.

2. Instruction.

Instruction is envisaged as teacher-centred (rather than objectives oriented), where knowledge is best presented in small steps. The crucial element for motivation is pupil' active participation in the lessons while reinforcement is considered an integral part of the teaching process.

3. Classroom activities.

Satisfactory classroom activities entail an understanding of pupils and their needs on the part of the teacher; teacher's guidance should aim at "active discovery" rather than put emphasis on clear explanations or any other feature of teaching.

VIII.5 ANALYSIS OF GROUP RESPONSES: How the positions are reflected by the "collective" opinion.

In what follows, the responses at the level of groups will be contrasted with the possible positions entailed by the background a-priori analysis. These positions can be understood to represent the various distinct paths in the systemic network (chapter IV).

The aim of this comparison is to explore how far the dominant pattern of views held by teachers (as a group) fits with, or fails to fit with the a-priori positions. Thus, one can look for some indications of the extent to which the empirically detected views of teachers are influenced by a certain coherent philosophical or other viewpoint.

The convention used for the construction of the comparative tables is that acceptance or clear rejection of any of the postulated positions is indicated respectively by "a" and "r", while the positions for which no clear tendency is expressed, are shown by an asterisk.

VIII.5.1 Philosophical component: An image of science.

According to the background argument one can distinguish three levels in terms of the philosophical systems involved:

I Level systems: Realism, Idealism, Scepticism (ontological question).

II Level systems: Scientific Realism, Logical Positivism and Pragmatism (philosophical systems which in a way are bridging epistemology and ontology).

III Level systems: Inductivism, Hyp.-Deductivism, Contextualism (two versions) and Relativism (epistemological systems).

The postulated position of each philosophical system, regarding a certain statement of the instrument, is taken from chapter III (see table T8.13 for references).

	Phil. systems.	Sections.
1.	Realism.	III.6.5
2.	Idealism.	III.6.5
3.	Scepticism.	III.6.5
4.	Sc. Realism.	III.6.5
5.	Log. Positivism.	III.6.5
6.	Pragmatism.	III.6.5
7.	Inductivism.	III.2.5
8.	Hypothetico-Deductivism.	III.3.3
9.	Contextualism A.	III.4.4.1
10.	Contextualism B.	III.4.4.2
11.	Relativism.	III.5.3

TABLE T8.13

Table T8.14 below portrays a comparison of the empirical evidence and the I and II level philosophical systems.

THE ISSUE OF REALITY.

		Realism	Idealism	Scepticism
	24a.	a		
I	24b.		r	
S	24c.			r
S				
U	Conclusion:			
E	On this level the choice is Realism overwhelmingly [24a].			
O				
F		Sc. Realism	Log. Positivism	Pragmatism
R				
E	25a.		r	r
A	25b.	a		
L	Conclusion:			
I	Scientific Realism is the chosen philosophical system on this			
T	level. The sample particularly oppose (97.9% reject them) the			
Y	ontological component of both Logical Positivism and Pragmatism.			

TABLE T8.14

This interpretation is consistent not only with the position on the I Level (Realism) but with the rejection of the epistemological component of Logical Positivism and Pragmatism as well (see table T8.15).

	Logical Positivism	Pragmatism
18a.	r	
18b.		*(r)
19a.	*(r)	

TABLE T8.15

The following tables T8.16, T8.17 and T8.18 (in which the same convention as in table T8.14 applies) deal with the themes of the philosophical epistemological systems of level III, namely the questions about scientific methodology, criteria of demarcation, pattern of scientific change and finally the status of scientific knowledge.

SCIENTIFIC METHODOLOGY.

		Inductivism	Hyp.-Deduct.	Contextualism A	Contextualism B	Relativism
S	3a.	r	r			
C	3b.			a	a	a
I.						
	4a.	a				
	4b.		r			
M	5a.	*				
E	5b.		*			
T						
H	6a.			a	a	
O	6b.					r
D						
O	16a.			a	a	
L	16b.					r
O						
G	17a.			a		
Y	17b.				*	
	17c.					a

TABLE T8.16

The pattern:

There are many ways of being scientific in terms of method [3b.]; rational and fruitful criteria to deal with methodological issues exist [6a] and [16a]; the choice of method is up to individuals who should take into account the consensus of the relevant community [17c] and [17a]. Science is "data" driven [4a].

Conclusion:

The evidence appears to reveal a standpoint close to both versions of contextualism plus some inductive influences.

CRITERIA OF DEMARCATION.

		Inductivism	Hyp.-Deduct.	Contextualism A	Contextualism B	Relativism
C	7a.	a	a		a	
R	7b.			r		r
I						
T.						
	8a.	a	a		a	
O	8b.			r		r
F						
D	20a.			*		
E	20b.					r
M	20c.	a	a		a	
A						
R						
K	18a.	r	r			
A	18b.	Epistemological component of pragmatism.				
T	18c.				a	
I						
O						
N	19a.	*(r)	*(r)			

TABLE T8.17

The pattern:

There are rational criteria regarding the choice of scientific theories [7a], [8a] and [20c]; the consensus of the relevant community is the best indicator for such a choice [18c].

Conclusion:

This pattern fits very well with the second version of contextualism.

PATTERN OF SCIENTIFIC CHANGE.

		Inductivism	Hyp.-Deduct.	Contextualism A	Contextualism B	Relativism
S	21a.	a	a		a	
C	21b.			a		a
I.						
G	22a.	a				
R	22b.		a			
O						
W						
T	23a.			a	a	
H	23b.					r

TABLE T8.17a

Note.

Here, the respondents appear to accept both alternatives in the pairs of statements (21a), (21b) and (22a), (22b). For this reason the interpretation in these cases will be based on the strength of the existing tendencies. Table T8.5c (Section VIII.4.1) indicates that statement (21b) carries a strong tendency and statement (22a) a very stong one. Consequently, they are better indicators of tendency than are statements (21a) and (22b) respectively, which only belong to the "clear tendency" category.

The pattern:

As science changes new knowledge replaces knowledge of another sort [21b] which could be incompatible with the old [23a]. New scientific knowledge arises through an accumulation of new experiments and observations [22a] (this is consistent with the assertion that science is "data" driven, [4a] above).

Conclusion:

The responses appear close to the first version of contextualism (moderate irrationalism) but the consistent emphasis on the role of data seems to be in tension with this system.

STATUS OF SCIENTIFIC KNOWLEDGE.

		Inductivism	Hyp.-Deduct.	Contextualism A	Contextualism B	Relativism
S						
C.						
	26a.	r	r		r	
K	26b.			a		a
N						
O						
W						
L	27a.	*	*			
E	27b.	Dimension of Pragmatism.				
D	27c.				a	
G						
E						

TABLE T8.18

The pattern.

Scientific knowledge is not special or unique [26b]. But it has some particular characteristics, namely "usefulness" [27b] and it is a systematic pattern of thought [27c].

Conclusion:

There is no satisfactory fit. The position displays some internal tensions which, however, are quite consistent with the similar tensions regarding the themes of scientific methodology and the pattern of scientific change.

VIII.5.2 Curricular component.

The curricular component of the instrument deals with two issues, namely:

-integrated science as opposed to the teaching of separate scientific subjects and

-the meaning of the terms content and process in the context of science teaching.

INTEGRATED SCIENCE V. SEPARATE SUBJECTS.

	Integrated science.		Separate subjects.
1b.	a	1a.	r
	Arguments for integrated science.		**Arguments for separate subjects.**
13a.	a	12a.	a
13b.	a	12b.	r
13c.	r	12c.	‡
13d.	a	12d.	r

TABLE T8.19

It appears that integrated science is thought to be the appropriate way of organising science education. A twofold reason is given for such a choice: on the one hand the basic unity of scientific concepts and on the other hand the need to make school science relevant to the pupils. The only argument which stands, according to the evidence gathered, in favour of teaching every scientific subject on its own, is differences in content between the subjects.

SCIENTIFIC CONTENT AND PROCESS.

	Related.		Unrelated.
2b.	a	2a.	r

	Meaning of content.		Meaning of process.
29a.	Low preference.	30a.	High preference.
29b.	Middle preference.	30b.	Low preference.
29c.	High preference.	30c.	Middle preference.

TABLE T8.20

The content of scientific subjects is considered connected with scientific process. Apart from this, of particular interest are the "definitions" attached to the above terms. Firstly, content is taken to signal mainly techniques of experimentation while scientific theories and laws get the lowest preference; secondly, scientific methodology is arguably the focus of the term "process". This stance seem to echo some of the 'science data driven' trends detected in the philosophical component previously (scientific methodology and pattern of scientific change).

VIII.5.3 Pedagogical component.

Three themes constitute the "pedagogical" component:

-assumptions about learning which include aims, prerequisite and assessment of learning;

-assumptions about instruction;

-assumptions about certain classroom activities.

ASSUMPTIONS ON LEARNING.

		Cognitivism.		Constructivism.		Behaviourism.
Aims of learning.	28a.	High preference.	28b.	Middle preference.	28c.	Low preference.
Prerequisite of Learning.	33c.	High preference.	33a.	Low preference.	33b.	Middle preference
Assessment of learning outcomes.	31b.	Middle preference.*	31c.	High preference.*	31a.	Low preference.

*Very close to each other.

TABLE T8.21

Clearly, cognitivism is the system with which the majority of teachers appear to agree.

The assumptions about instruction and classroom interaction include several distinct elements, but no definite systems have been formulated, in contrast to the other themes of the study, due to the nature of questions under consideration, which being much closer to practice, preclude the use of theoretical constructs. Thus, the previous analysis (section VIII.4.3) includes all that can be said at this stage.

In this preliminary analysis the goal was to reveal the dominant pattern of teachers' views, analysing their responses at the level of the whole sample and without taking into account the extent to which particular individuals follow consistently a particular path in the network. Thus, this treatment of the empirical evidence seems to indicate that contextualism (second version) is the system to which the majority of teachers subscribe in the epistemological level. At the ontological level realism/scientific appear to be the choice. In as far as the assumptions about learning are concerned the preferred system is cognitivism while the teaching of integrated science both because of conceptual and methodological similarities and because it is considered that integrated science facilitates towards making knowledge socially relevant, is teachers' favoured position.

It is not possible however, analysing the data this way to discern the extent to which the above pattern reflects a consistent stance or is the result of accumulated unsystematic choices. Nor it is possible to discern other coherent patterns which co-exist besides the "dominant" one. These points will be the focus of the next stage of analysis.

VIII.6 SECOND STAGE: Analysis of theme patterns.

In this second stage of the analysis the target is twofold:

-to pick up those of the individual respondants who appear to have views which could be seen in accordance with the background analysis as this analysis is realised by the systemic network and secondly to discuss what these expressed views entail in terms of the network regarding all the components (philosophical - epistemological, curricular and pedagogical).

-to analyse differentiation of opinions in terms of sub-groups i.e. P.G.C.E students - practising teachers on the one hand and physicists - chemists - biologists on the other.

The essential difference between this stage of the analysis and the previous part is that here the element of "consistency" is introduced. This means that the classification of people into distinct categories (i.e. inductivism, relativism, etc.) is made on the basis of their following consistently a particular path of the network, (as represented by the respective statements) each of which corresponds to a certain position. The definition of "consistent following" has been made operational through the use of a set of somewhat stringent criteria (i.e. people to be categorised as inductivists with regard to scientific methodology for instance, should have accepted or rejected a considerable number of statements).

The specifications of each system in terms of their respective statements, for all the themes under consideration and also the percentages of people who followed each system, are given below in tables T8.22 to T8.32. Additionally, a brief discussion of the salient points emerging from each of the following tables will be presented.

The sub-routine "cross-tabulation" of the SPSSx package was used for the present analysis [1].

VIII.6.1 Philosophical component.

The themes of scientific methodology, criteria of demarcation and pattern(s) of scientific change will be discussed together in the following not only because they are interrelated but also because this conceptual closeness is reflected by the views which teachers appear to hold.

With regard to the first two of the above mentioned themes as well as the status of scientific knowledge, a further category was introduced in addition to those postulated by the a-priori analysis systems to cater for those people who appear undecided about the finer distinctions involved in the definition of the respective systems, whilst otherwise subscribing to these systems. These categories are: undecided contextualists (for the theme of scientific methodology) and undecided rationalists (for both the themes of criteria of demarcation and the status of scientific knowledge).

SCIENTIFIC METHODOLOGY.

A. Specification of the positions.

		Statements ought to be accepted.	Statements ought to be rejected.
1.	Inductivism.	3a,4a,5a	3b,4b,5b
2.	Hypothetico-Deductivism.	3a,4b,5b	3b,4a,5a
3.	Contextualism B./A.	3b,6a,16a,(17a or 17b)	3a,6b,16b
4.	Undecided Contextualists	3b,6a,16a,17a,17b,17c	3a,6b,16c
5.	Relativism.	3b,6b,16b,17c	3a,6a,16a

B. Their influence (% people).

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Inductivism.	16.8	04.9	25.9	07.4	11.5	26.8
2.	Hypothetico-Deductivism.	05.3	04.9	05.6	00.0	00.0	12.2
3.	Contextualism B/A.	23.2	29.3	18.5	40.7	07.7	22.0
4.	Undecided Contextualists.	12.6	07.3	16.7	25.9	11.5	04.9
5.	Relativism.	00.0	00.0	00.0	00.0	00.0	00.0
	Total.	57.9	46.4	66.7	74.0	30.7	65.9
		----	----	----	----	----	----
6.	Eclectic.	42.1	53.6	33.3	26.0	69.3	34.1

TABLE T8.22

CRITERIA OF DEMARCATION.

A. Specification of the positions.

		Statements ought to be accepted.	Statements ought to be rejected.
1.	Ind./Hyp.-Ded.("Truth")	7a,20c,18a	7b,18b,18c
2.	Context. B./Pragmatism	7a,20c,(18b or 18c)	7b,18a
3.	Undecided Rationalists	7a,20c,18a,18b,18c	7b
4.	Context. A./Relativism	8b,(20a or 20b)	8a

B. Their influence (% people).

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Ind./Hyp.-Ded.("Truth")	11.6	19.5	05.6	22.2	03.8	09.8
2.	Context. B./Prag.	30.5	17.1	40.7	29.6	42.3	24.4
3.	Undecided Rational.	07.4	02.4	11.1	11.1	03.8	07.3
4.	Context. A./Relat.	11.6	12.2	11.1	07.4	03.8	19.5
	Total.	61.1	51.2	68.5	70.3	53.7	61.0
		----	----	----	----	----	----
5.	Eclectic.	38.9	48.8	31.5	29.7	46.3	39.0

TABLE T8.23

PATTERN OF SCIENTIFIC CHANGE.

A. Specification of the positions.

		Statements ought to be accepted.	Statements ought to be rejected.
1.	Inductivism.	21a,22a	21b,22b
2.	Hypothetico-Deductivism.	21a,22b	21b,22
3.	Contextualism B.	21a,21b,23a	23b
4.	Contextualism A.	21b,23a	21a,23b
5.	Relativism.	21b,23b	21a,23a

B. Their influence (% people).

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Inductivism.	07.4	07.3	07.4	03.7	11.5	07.3
2.	Hypothetico-Deductivism.	00.0	00.0	00.0	00.0	00.0	00.0
3.	Contextualism B.	35.8	29.3	40.7	22.2	38.5	41.5
4.	Contextualism A.	18.9	22.0	16.7	48.1	07.7	07.3
5.	Relativism.	04.2	02.4	05.6	00.0	00.0	09.8
	Total.	66.3	61.0	70.4	74.0	57.7	65.9
		----	----	----	----	----	----
6.	Eclectic.	33.7	39.0	29.6	26.0	42.3	34.1

TABLE T8.24

From an inspection of the above three tables, it appears that teachers to a large extent do have discernible views. This is illustrated by the fact that approximately 60% of the people revealed a preference for one particular stance. Generally speaking, relativism and hypothetico-deductivism received scant support - whilst in the case of inductivism it is worth noting that in relation to scientific methodology - 16.8% of the people selected this system. More than double however (in all 35.8%) favour one or another version of contextualism (including the undecided contextualists).

As far as the differences between the various sub-groups in relation to the choice of scientific method(s) are concerned, a number of distinctions emerge (see table T8.22):

Firstly, there is a difference between teachers and students - the former being more disposed towards inductivism. Previous research in this area bears testimony to this point, having demonstrated that teachers tend to favour this stance. It is possible that this trend could be declining, as suggested by the students' preference for contextualism.

Secondly, it can be seen that Biology teachers were the major group adhering to inductivism (see table T8.22). This could be due to the nature of the subject matter itself which as taught in schools can be seen as lending itself towards this system. Physics teachers on the other hand favoured more than any other group contextualism (66.6%). This too could be accounted for by the subject matter itself, which has in the last few decades become more informed by philosopical debates so that this factor may exert an influence on the choice made [2]. Interestingly, chemists apear in a in-between position, having the higher percentage of eclectics.

When examining the criteria of demarcation (see table T8.23) it becomes clear that P.G.C.E. students are more inclined towards the notion of "truth" being a central element than teachers - (as implied by the predominance of inductivism and hypothetico-deductivism in the former's thinking).

Moreover, it can be seen that Chemistry teachers were the group most in favour of contextualism/pragmatism - which again could be as a consequence of the nature of the subject matter. Of interest is the observation that out of all the sub-groups, Physics teachers were the most committed to any one particular stance - i.e. they reflected only a small amount of eclecticism in comparison with the other groups.

In relation to patterns of scientific change, contextualism B again emerged as the most frequently chosen system by all groups (see table T8.24).

However, as a sub-group Physics teachers appear to have chosen mainly contextualism A, which is in contrast to their choices in relation to scientific methodology and criteria of demarcation - (i.e. contextualism B - which places particular emphasis on "rationality").

STATUS OF SCIENTIFIC KNOWLEDGE.

A. Specification of the positions.

		Statements ought to be accepted.	Statements ought to be rejected.
1.	Ind./Hyp.-Ded.("Truth")	26a,27a	26b,27b,27c
2.	Context. B./Pragm.	26a,(27b or 27c)	26b,27a
3.	Undecided Rationalists.	26a,27a,27b,27c	
4.	Context. A./Relat.	26b	26a,27a

B. Their influence (% people).

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Ind./Hyp.-Ded.("Truth")	00.0	00.0	00.0	00.0	00.0	00.0
2.	Context. B./Pragm.	07.4	07.3	07.5	03.7	03.8	12.1
3.	Undecided Rationalists.	14.7	12.2	16.7	44.4	03.8	02.4
4.	Context. A./Relat.	54.7	58.5	51.9	37.0	42.3	75.6
	Total.	76.8	78.0	76.1	85.1	49.9	90.1
		----	----	----	----	----	----
5.	Eclectic.	23.2	22.0	23.9	14.9	50.1	09.9

TABLE T8.25

As far as the status of scientific knowledge was concerned, the predominant choice was contextualism A/relativism (see table T8.25).

No difference between P.G.C.E. students and teachers emerged. However, between the various teaching groups a number of distinctions can be discerned:

Firstly, it was biology teachers who most often chose relativism - this figure (75.6%) being almost double those for the physics and chemistry teachers. Furthermore, they were the least eclectic group. Their preference for relativism could be explained if one takes into consideration the perceived status of biology: it is often seen as less prestigious than the other two scientific subjects; perhaps in some sort of defense it is possible that they treat all sorts of knowledge as equally worthwhile. The choice of relativism/contexualism A on the part of physics teachers is in accordance with their choice in "patterns of scientific change"; however in the case of chemistry teachers, this indicates a deviation from the previous choice of contextualism B, as seen in the previous tables. The situation here can be compared with the inversed pattern regarding the theme of scientific methodology: a similar differentiation between the groups was revealed, but there the biologists occupied the traditional position while here they have switched to relativism.

Clearly then, there is a movement towards the relativistic end of the spectrum of epistemological systems which demonstrates a shift in allegiance from the more "rationally-bound" systems, which were predominant with regard to the three previous themes (tables T8.22, T8.23, T8.24). That is, if people are asked directly whether science is "objective" or "true", then adopt a more relativistic position than when they are asked whether one can demarcate between science and non-science or whether science grows (as opposed to simply changes).

THE ISSUE OF REALITY.

A. Specification of the positions.

		Statements ought to be accepted.	Statements ought to be rejected.
1.	Idealism.	24b	24a,24c
2.	Scepticism.	24c	24a,24b
3.	Realism-Sci. Realism.	24a,25b	24b,24c,25a
4.	Log. Positivism.	24a,25a,19a	24b,24c,25b
5.	Pragmatism.	24a,25b,18a	24b,24c,25a

B. Their influence (% people).

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Idealism.	22.1	17.1	25.9	18.5	11.5	31.7
2.	Scepticism.	03.2	07.3	00.0	00.0	00.0	07.3
3.	Realism-Sci. Realism.	40.0	46.3	35.2	40.7	50.0	31.7
4.	Log. Positivism.	00.0	00.0	00.0	00.0	00.0	00.0
5.	Pragmatism.	01.1	02.4	00.0	03.7	00.0	00.0
	Total.	66.4	73.1	61.1	62.9	61.5	70,7
6.	Eclectic.	33.6	26.9	38.9	37.1	38.5	29.3

TABLE T8.26

In examining responses to the issue of reality, realism-scientific realism emerged by a long way as the most popular system - in particular this is reflected in the choices made by chemistry teachers. The only exception to this was in the case of Biology teachers, who chose realism and idealism in equal proportions. The systems of logical positivism and pragmatism (II level systems) were notably absent.

Also evident is the fact that the division between idealism and realism was more pronounced amongst P.G.C.E. students than amongst teachers. Furthermore, the former group was less eclectic in orientation than any other group.

VIII.6.2 Curricular and Pedagogical components.

The parts of the network which refer to the curricular and pedagogical components (with the exception of the theme "assumption about learning") contain a considerable number of paths corresponding to different stances. Only the stances of interest in terms of popularity are included in the following tables. So, another category ("other stances" as distinct from "eclectic") was created to acommodate the people who follow the network but do not subscribe to one of the main positions (as far as the empirical evidence is concerned).

1. Integration of scientific subjects.

A. Specification of the positions.

	Statements ought to be accepted.	Statements ought to be rejected.
Integrated: Content-Methods-Soc. Relevance.	1b,(13a or 13b or 13d)	1a,13c
Integrated: Practicalities.	1b,13c	1a,13a,13b,13d
Separate subjects: Content-Practicalities.	1a,(12a or 12c)	1b,12b,12d
Separate subjects: Other reasons.	1a,(12b or 12d)	1b,12a,12c

B. Their influence.

Choice. Reasons for choice.	Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
Integrated: Content-Methods-Soc. Relevance.	35.8	41.5	31.5	25.9	42.3	36.6
Integrated: Practicalities.	20.0	17.1	22.1	37.0	07.7	17.1
Separate subjects: Content-Practicalities.	24.2	19.5	27.8	22.2	23.1	26.8
Separate subjects: Other reasons.	08.4	04.9	11.1	03.7	23.1	02.4
Total.	88.4	83.0	92.6	88.8	96.2	82.9
Others.	11.6	17.0	07.4	11.2	03.8	17.1

TABLE T8.27

The idea of an integrated science curriculum received support from nearly 60% of the people. The reasons chosen for this are related to their conceptions of the meaning of content and method in science - apart from the belief that there exists a common conceptual and methodological framework for all scientific subjects, integrated science teaching was seen to make the subject more socially relevant. Chemistry and biology teachers were the most committed towards an integrated science curriculum, the former being the most determined in this respect. This is concordant with the strong stance they (i.e. the chemistry teachers) manifested in the criteria of demarcation and in the status of scientific knowledge - themes which are conceptually related to their justifications for choosing either integrated or separate science subject teaching.

The P.G.C.E. students, in relation to both integrated science and separate subject teaching, disregarded - more than any other group - practical considerations.

This reasoning is interesting as it contrasts quite sharply with those who demonstrated a preference for teaching scientific subjects as separate - the latter group basing their choice on the grounds of practical considerations.

2. Scientific content and process.

A. Specification of the positions.

	Statements ought to be accepted or preferred.	Statements ought to be rejected or given low priority.
Related: Scientific Laws -Handling of exper. data.	2b,9c,29a,30b	2a,9a,9b,29b,29c,30a,30c
Related: Experimental data-Scientific methodology.	2b,9c,29b,30a	2a,9a,9b,29a,29c,30b,30c
Related: Experimental data-Experimentation.	2b,9c,29b,30c	2a,9a,9b,29a,29c,30a,30b
Unrelated:Experimental data-Experimentation.	2a,9c,29b,30c	2b,9a,9b,29a,29c,30a,30b
Unrelated:Experimental data-Scientific methodology.	2a,9c,29b,30a	2b,9a,9b,29a,29c,30b,30c

B. Their influence.

Meaning of content. Meaning of process.	Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
Related: Scientific Laws -Handling of exper. data.	04.2	02.4	05.6	14.8	00.0	00.0
Related: Experimental data-Scientific methodology.	21.1	34.1	11.1	22.2	19.2	22.2
Related: Experimental data-Experimentation.	44.2	36.6	50.0	11.1	53.8	58.5
Unrelated:Experimental data-Experimentation.	07.4	02.4	11.1	11.1	11.5	02.4
Unrelated:Experimental data-Scientific methodology.	10.5	04.9	14.8	22.2	00.0	09.8
Total.	87.4	80.4	92.6	81.4	84.5	92.7
	----	----	----	----	----	----
Other stances.	12.6	19.6	07.4	18.6	15.5	07.3

TABLE T8.28

In relation to conceptions of scientific content and process most people placed the emphasis on the experimental contents of teaching; whilst only 4% saw scientific laws as being pertinent to content.

Physics teachers constituted an exception to this trend: 14.8% (when the respective percentages are zero for biology and chemistry teachers) believed that content consists of scientific laws. As far as the meaning of process is concerned, 44.4% of physics teachers attached methodological considerations to it. This view was shared by a considerable proportion of the P.G.C.E. students.

This is in contrast to the conceptions held by most of the chemistry and biology teachers, who understood process to be bound up with experimentation (whereas it had been intended that methodological considerations included ideas and processes in addition to experimentation).

3. Assumptions about learning.

A. Specification of the positions.

	Statements ought to be accepted or preferred.	Statements ought to be rejected or given low priority.
1. Cognitivism.	28a,31b,33c	28b,28c,31a,31c,33a,33b
2. Behaviourism.	28c,31a,33b	28a,28b,31b,31c,33a,33c
3. Constructivism.	28b,31c,33a	28a,28c,31a,31b,33b,33c

B. Their influence.

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	Cognitivism.	27.4	17.1	35.2	18.5	34.6	29.3
2.	Behaviourism.	11.6	14.6	09.3	07.4	11.5	14.6
3.	Constructivism.	16.8	12.2	20.4	18.5	23.1	12.2
	Total.	55.8	43.9	64.9	44.4	69.2	56.1
4.	Other stances.	44.2	56.1	35.1	55.6	30.8	43.9

TABLE T8.29

"Cognitivism" emerged as the most frequently chosen set of assumptions about learning - 27.4% of the people subscribing to this system. This choice however, was by no means in the majority - "other stances" in fact attained the highest percentage of responses. Out of all the systems, "behaviourism" was the option favoured least, while "constructivism" had a marginally higher following.

Given the nature of the questions under consideration here (which are more directly relevant to teaching than, for instance, philosophy of science) and the high percentage of people who appear to fall in the category "other stances" (44.2%), it could be said that whilst this outcome may be a genuine phenomenon, it could also be indicative of a weakness of the a-priori analysis used in the construction of the research instrument.

A number of differences did emerge between the various subgroups which warrant mention: teachers and P.G.C.E. students differed in that the former subscribed to a larger extent to constructivism; furthermore, more chemists and physicists supported constructivism than did biologists.

4. Assumptions on instruction.

Table T8.30 displays the specification of the various stances with regard to assumptions about instruction and their influence on teachers views. In addition, given that the formulation of these stances was based on the extent to which teachers appear to accept (or reject) a certain version concerning a number of rather "autonomous" elements (e.g. motivation, presentation-pacing of knowledge etc.) these stances are identified by abbreviations related to the constituent elements.

Positions.	Abbreviations.
1. Orientation of instruction.	
Objectives oriented.	OO
Teachers oriented.	TO
Balanced orientation.	BO
2. Presentation of knowledge.	
Small steps.	ST
Whole idea.	WI
3. Motivation.	
Act. participation.	AP
Emotional involment.	EI
Feedback.	FE
4. The role of reinforcement.	
Integral/essential.	IN
Irrelevant.	IR
Occasionally.	OC

A. Specification of the positions.

		Statements ought to be accepted or preferred.	Statements ought to be rejected or given low priority.
1.	TO-ST-AP-OC.	15b,32a,34a,14b	15a,32b,34b,34c,34d,24e,14c
2.	BO-ST-AP-IN.	15a,32a,34a,14a	15b,32b,34b,34c,34d,24e,14c
3.	BO-ST-AP-OC.	15a,32a,34a,14b	15b,32b,34b,34c,34d,24e,14c
4.	BO-ST-EI-IN.	15a,32a,34b,34c,34d,14a	15b,32b,34a,34e,14c
5.	BO-ST-EI-OC.	15a,32a,34b,34c,34d,14b	15b,32b,34a,34e,14c
6.	BO-WI-AP-OC.	15a,32b,34a,14b	15b,32a,34b,34c,34d,24e,14c
7.	BO-WI-EI-IN.	15a,32b,34b,34c,34d,14a	15b,32a,34a,34e,14c

B. Their influence.

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	TO-ST-AP-OC.	05.3	04.9	05.6	00.0	07.7	04.9
2.	BO-ST-AP-IN.	09.5	02.4	14.8	11.1	07.7	09.8
3.	BO-ST-AP-OC.	16.8	07.3	24.1	00.0	23.1	24.4
4.	BO-ST-EI-IN.	10.5	09.8	11.1	07.4	00.0	19.5
5.	BO-ST-EI-OC.	12.6	14.6	11.1	18.5	11.5	09.8
6.	BO-WI-AP-OC.	14.7	26.8	05.6	25.9	11.5	09.8
7.	BO-WI-EI-IN.	03.2	07.3	00.0	00.0	00.0	07.3
	Total.	72.6	73.1	61.2	62.9	61.5	85.5
8.	Other stances.	27.4	26.9	27.8	37.1	38.5	14.5

TABLE T8.30

With regard to the assumptions about theories of instruction, no clear choice emerged - the responses were evenly distributed.

This homogeneity however obscures a pattern in which a distinction between P.G.C.E. students and physicists on the one hand and teachers and chemists and biologists on the other can be drawn: the latter group revealed a preference for balanced orientation, teaching in small steps, active participation and the occasional use of reinforcement (BO-ST-AP-OC), whilst the former shared a preference for balanced orientation, teaching the whole idea, active participation and the occasional use of reinforcement (BO-WI-AP-OC). What then differentiates these two groups is the different orientations in relation to the presentation of knowledge.

5. Assumptions on classroom activities.

As previously, in the following table T8.31 the identification of the formulated stances by abbreviations is also included.

Positions.	Abbreviation.
Crucial element in science lessons activities.	
Clear explanations.	CE
Pupils investigations.	PI
Guided discovery.	GD
Active discussions.	AD
Traits of successful teacher.	
Knowledge of subject.	KS
Understanding of pupils' thinking.	UP
Effective teaching techniques	ET
Respect of pupils decisions.	RP

A. Specification of the positions.

		Statements ought to be accepted or preferred.	Statements ought to be rejected or given low priority.
1.	CE/GP and KS/ET	35a,35c,36a,36c	35b,35d,36b,36d
2.	PI/AD and KS/ET	35b,35d,36a,36c	35a,35c,36b,36d
3.	CE/GP and UP/RP	35a,35c,36b,36d	35b,35d,36a,36c
4.	PI/AD and UP/RP	35b,35d,36b,36d	35a,35c,36a,36c

B. Their influence.

		Whole Sample.	P.G.C.E. Students.	Teachers.	Physics.	Chemistry.	Biology.
1.	CE/GP and KS/ET	47.4	39.0	53.7	44.4	69.2	36.6
2.	PI/AD and KS/ET	27.3	19.5	33.3	29.6	00.0	43.9
3.	CE/GP and UP/RP	07.4	09.8	05.6	14.8	07.7	02.4
4.	PI/AD and UP/RP	15.8	29.3	05.6	11.1	19.2	17.1
	Total.	97.9	97.6	98.2	99.9	96.1	100
5.	Other stances.	02.1	02.4	01.8	00.1	03.9	00.0

TABLE T8.31

The essential components of classroom practice were identified as being clear explanation, guided discovery, knowledge of the subject matter and effective teaching techniques.

This combination, which suggests a teacher-centred approach to practice, was subscribed to by the majority of physicists. As far as the chemists and biologists were concerned, whilst they both accepted knowledge of the subject matter and effective teaching techniques as fundamental to classroom activities, they had a bias towards differing components: the former placed great stress on clear explanation and guided discovery, whilst the latter tended to emphasise more the qualities of teacher in terms of mastery of the subject-matter and teaching techniques.

The only group to advocate a comprehensive pupil-centred approach was the P.G.C.E. students, who perceived the essential elements of classroom activities to comprise investigations by pupils, active discussions, understanding of pupils' thinking and respect for pupils decisions.

A possible explanation for this could be experience located in the current courses in colleges of education, which stress a pupil-centred approach to teaching - an approach which is not yet mitigated by direct experience and the day-to-day realities of classroom life.

VIII.6.3 Discussion of positions identified.

Before discussing the positions, it should be noted that the evidence suggests that teachers do in fact have identifiable philosophical positions. Indeed, the views of the majority (in the region of 60%-70%) can be identified with some coherent philosophical system. The inference that teachers' views can be identified is in accordance with previous research finding e.g. Dibbs [3]. This seems to provide some answer to the legitimate objection of not asking people about issues which they have never previously thought about.

However, in the first instance the percentage of eclectics seems to be rather high (see tables T8.22 to T8.31). In fact if one looks at it as a separate category, it often outnumbers other categories (particularly as far as the epistemological component is concerned). But, there are two further elements which should be considered when debating this problem:

-Firstly, it is argued here that given the nature of the issues under consideration, it is not surprising to detect a substantial percentage of people who are genuinely eclectic. Furthermore, despite the use of stringent criteria on the definition of the various categories-systems, generally fewer people appear to be eclectic than previous studies - constructed to include more than two philosophical systems - have reported.

Thus Dibbs [4] for instance, reports that "examination of the scores obtained by individual teachers on the total scales showed that a few were indeed extreme types in terms of the definitions given above. Many more showed either no particular bias or inclined away from one position while having leanings towards both of the alternatives". Ogunniyi [5] does not report any percentage of eclectics as such, but an inspection of the answers which agree with every alternative offered, indicates a high number of people falling into this category. Finally, according to Rowell and Cawthron [6] who use factor analysis in order to reconstruct teachers' epistemological views, as the loading of each factor indicates, conflicted ideas have penetrated the educational system. This difference between the present and previous studies may be due on the one hand to the inclusion in this study of more systems of thought and on the other hand, to the analysis of teachers philosophical-epistemological views along various themes (e.g. scientific methodology, the status of scientific knowledge, etc.) instead of treating them as one entity.

-Secondly, the "eclectic" category is not treated here as a "dust bin" category. On the contrary, an attempt follows to further analyse this category so that to discern whether eclectic views are in any way related with the general tendencies which emerge from the identifiable positions. The reason why these views are analysed separately is that it is thought conducive to the discussion to distinguish the identification and analysis of strictly speaking coherent philosophical positions from questions about the contingent co-existence of elements drawn from perhaps strictly speaking contradictory systems in any one person's thought - i.e. the study of correlations of views on a purely empirical basis.

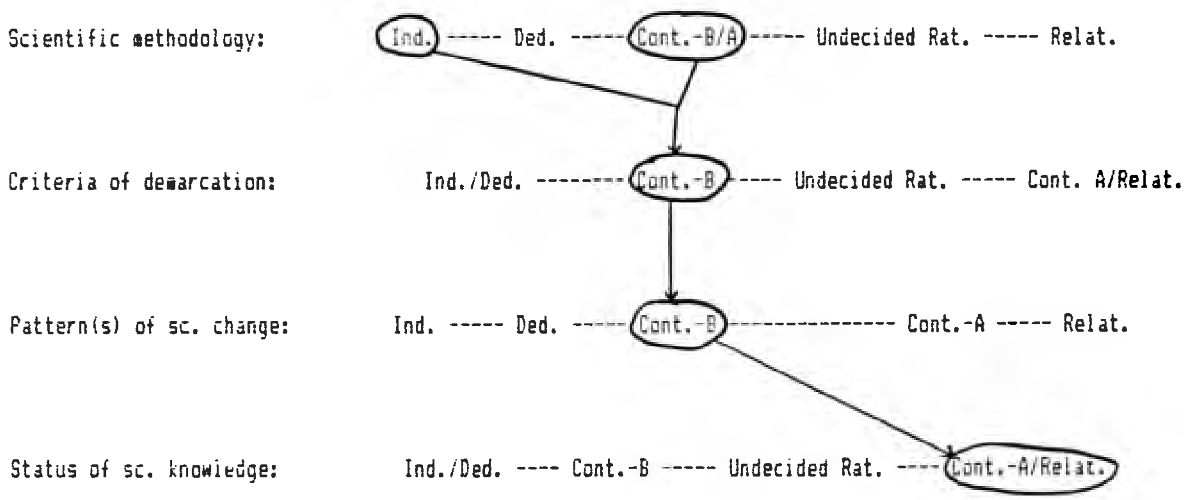
In comparing the results of this study with previous research findings, it is helpful to envisage the various epistemological positions as four continua (each corresponding to a different theme). The role of rationality in science underpins these continua, of which the one extreme is occupied by inductivism and the other by relativism.

Previous research findings indicate that teachers tend to subscribe to those philosophical positions which emphasise the role of rationality in science, mainly inductivism (relatively more recent positions i.e. those by Kuhn or Feyerabend have been reported not to appear in teachers' views [7]).

On the other hand from this study, it appears that the prevailing position (followed consistently within each theme) in terms of scientific methodology, criteria of demarcation and pattern of scientific change is version B of contextualism which Newton-Smith calls "embryonic rationalism" [8], while with regard to the status of scientific knowledge, teachers subscribe to the view that scientific knowledge is not unique or privileged vis-a-vis other forms of knowledge. This position resembles relativism, or version A of contextualism (a more relativistic reading of Kuhn as argued in section

III.4).

Thus, the picture emerging is more complicated than the assertion that the findings of this research indicate a shift in epistemological allegiances away from empirico-inductivism, since the extent of this movement depends on the theme one addresses. Schematically, the resulting situation is represented below.



These views on the epistemological level should however be seen in the light of teachers' answers to the ontological question, in which they seem to support realism and scientific realism. One may note that philosophers close to a contextualist B position (e.g. Ziman [9]) also tend to some version of realism.

For curriculum and pedagogy one could distinguish between "traditional" approaches (teaching of separate subjects, teacher and/or subject-centred approach in pedagogy) as opposed to more "radical" approaches (integrated science, pupil-centred approach, stress of importance of pupils' active role in lessons). Then, the change in philosophical orientation is coupled with support for an integrated science curriculum, significantly not for practical reasons but rather based on epistemic considerations. Interestingly enough (if one takes into account changes in the philosophical and curricular component) the indication is that teachers appear to be more on the traditional side, particularly regarding the way teachers conceive learning. One might, with some exaggeration, suggest that teachers accept fundamental reasons for change in curriculum, and will the end, but not yet the means.

Finally, comparing the outcome of this analysis - which takes into account the consistency with which every individual follows a particular system and what the analysis at the level of groups indicates, it is evident that what previously was detected is corroborated in this stage.

Summarising, if both the previous research and the present study are valid and reliable, there is here some evidence of a complex pattern of change in teachers' thought in terms of the philosophical-epistemological component, while with regard to the pedagogical components generally teachers still lean more to traditional stances (teachers of biology being the more "radical" in this sense).

A hypothesis towards explaining these differences can be established along the lines that either the inclusion of more stances in the instrument gave teachers the opportunity to locate themselves more precisely, or that given that the views of individuals are not something stable and unaltered, the present findings reflect the direction of change since previous studies were done.

The above discussion raises four questions:

-Does the same individual who consistently follows, for instance inductivism, in terms of scientific methodology, subscribe to the same system with regard to criteria of demarcation, etc.? In other words how are the detected views within each theme articulated across themes? Furthermore, is there any relation between choices in the philosophical component and in the curricular/pedagogical components? For example, do people who prefer inductivism - historically the more traditional philosophy of science - appear to espouse equally traditional curricular and pedagogical views?

-Is there any relation between the views of people who appear to be eclectic and the emerging general pattern?

-What inferences can be drawn for the validity and reliability of the research instrument taking into account the above analysis?

-What are the implications of teachers' views with regard to science teaching?

The second question constitutes the focus of the next section VIII.7, the first will be discussed in section VIII.8, while the last two questions will be dealt with subsequently.

VIII.6.4 An analysis of the "eclectic" category.

People whose views did not correspond to a definite "path" of the network(s) were put in the "eclectic" category. It was further argued that there is a need to investigate what the relationship is between the views of people who appear to be eclectic and the a-priori analysis. Thus, this section sets out to achieve this aim. A further element of this analysis is to detect whether a movement away from empirico-inductivism occurs as well as to check the differentiation of "eclectics'" views in relation to different themes against the background of the already discerned, prevailing for people with identifiable views pattern.

For this purpose the correlations (treated as contingencies) of responses to the group of statements which represent each position (see tables T8.22 to T8.31 for references) will be studied.

To implement this analysis, statements representing conceptually related issues are collapsed so as to generate more general variables. Subsequently, using the "cross-tabulation" procedure of the SPSSx package [10], the existence of correlations between the answers to every possible pair of the newly generated statements for a given theme is checked. The last step is to inspect the standardised residuals, which are reported by the cross-tabulation procedure. The standardised residuals show the difference between observed and expected value for each cell, in terms of the standard error of the expected values [11]. Looking therefore, at the size of the standardised residuals for these correlations which are significant statistically (level of significance 0.05 or better) the pattern(s) - if any - of teachers' views (who have been previously put in the "eclectic" category) on the relevant issues can be discerned.

Tables T8.33 to T8.37 indicating the size of the standardised residuals for every cell follow the convention:

sr>1.00 or <-1.00 + or - respectively;
sr between -1.00 and 1.00 blank (no association).

TABLE T8.32

Lastly, more about the reasons for both the choice of standardised residuals as a guide to discern possible patterns and the selection of the value 1.00 as the limit are explained in next section VIII.7.

It should be noted that this analysis is relevant to all themes of the epistemological-philosophical component and to the theme concerning assumptions about learning (pedagogical component). For the remaining themes of the pedagogical and curricular components such an analysis is not considered helpful for two reasons:

-firstly, because the percentages falling into the eclectic category are very small (in the region below 10%);

-secondly, because as already stated the responses to the statements of these themes have not been analysed on the basis of a-priori constructed systems but rather the construction of the categories-systems was made on the basis of the empirical evidence. Thus, below each of these themes is discussed separately.

A. Scientific methodology.

Scientific methodology is the largest theme constituted by six groups of statements. Looking at the responses to pairs of groups of statements for correlation, the followning pairs are correlated:

3a,3b and 6a,6b (at 0.01, Cramer's V=0.53);

3a,3b and 5a,5b (at 0.01, Cramer's V=0.43);

4a,4b and 5a,5b (at 0.08, Cramer's V=0.32 - 0.08 was judged to be sufficient);

6a,6b and 16a,16b (at 0.01, Cramer s V=0.46).

Responses therefore to the group af statements 17a,17b,17c do not correlate with other group of statements.

3a,3b\6a,6b	rational criteria	no rational criteria
one method	+	-
many methods		

3a,3b\5a,5b	verification	falsification
one method	-	+
many methods		-

4a,4b\5a,5b	verification	falsification
inductive reasoning		
deductive reasoning		-

6a,6b\16a,16b	many methods positive	many methods pointless to discuss
rational criteria	-	+
no rational criteria	+	-

TABLE T8.33

An inspection of the above table reveals that two distinct patterns emerge. The constituents of the first pattern are: that there is basically one scientific method based on rational criteria, indifferent to the distinction between inductive and deductive reasoning, but should feature falsification. It appears however, that the last element of this pattern, namely the view that the existence of various incompatible scientific methods shows the pointlessness of discussions about scientific methodology, is in tension with the previous ones. This tension may be a genuine reflection of the views of people who belong to this category, but it may also be a weakness in expressing the relevant ideas by statements 16a and 16b, since these statements convey two notions each, i.e. on the one hand the existence of incompatible scientific methods and on the other hand the implications of such a situation. It should be noted that in the administration of the research instrument, teachers were asked to indicate disagreement with any double-notion statement (and there are two such groups of statements, i.e. groups 16 and 20) if they disagreed with any of the notions contained by the statement.

According to the second discernible pattern, there are many legitimate scientific methods, but no rational and defensible ways for choosing among them. Nevertheless, verification is an essential characteristic of the scientific methods and their proliferation is a fruitful source of scientific progress.

With regard to the degree of fit of the above two patterns with the a-priori analysis, it is clear that they do not correspond to any of the foreseen paths of the relevant network, even if - according to the way rationality is conceived within them - they could be characterised in the first case more "traditional" and in the second case more relaxed.

B. Criteria of demarcation.

Here, evidence of correlations were found for the following pairs of group of statements:

7a,7b and 8a,8b (at 0.01, Cramer's V=0.44);

8a,8b and 20a,20b,20c (at 0.01, Cramer's V=0.55).

7a,7b\8a,8b	rational criteria	no rational criteria
rational criteria		-
no rational criteria		+

8a,8b\20a,20b,20c	new frameworks	relativism	fruitful
rational criteria			
no rational criteria	-		+

TABLE T8.34

On the basis of the above table, it appears that teachers tend to reject rational criteria for the inclusion of theories in science, retaining however, that the search for general rules for that purpose could be a fruitful enterprise.

It seems that a kind of internal friction is present in this position. Given that the group of statements 20 (statements 20a, 20b, 20c) runs into the same difficulties as the group of statements 16, the same hypotheses and the same qualifications towards explaining this outcome as in the case of the first discerned pattern regarding scientific methodology are also applicable here.

C. Pattern(s) of scientific change.

This theme consists of three groups of statements, namely 21a,21b 22a,22b and 23a,23b. The responses to the first and last groups are correlated significantly at less than 0.01 level the Cramer's V coefficient for this correlation being 0.72.

21a,21b\23a,23b	through frameworks	unpatterned frameworks
growth	+	-
change	-	+

TABLE T8.35

The interpetatation of this correlation is rather straightforward. Teachers in this category tend to believe that science grows (as opposed to simple change) and that this happens through a succession of knowlegde frameworks - sometimes compatible and sometimes incompatible with each other. This position is rather close to Contextualism B and it could have been included in this system if less stringent criteria have been applied.

D. The status of scientific knowledge.

The pair of groups of statements which represent this theme (26a,26b and 27a,27b,27c) is correlated (level of significance=0.01, Cramer's V=0.77)

26a,26b\27a,27b,27c	objective account useful	objective account useful systematic pattern
unique	+	-
both special and not different	-	

TABLE T8.36

The pattern one could establish with regard to the status of scientific knowledge concerns only one group. Thus, there is a positive association between the views of people who consider science in a way privileged vis-a-vis other forms of knowledge and the justification of this special status asserting that scientific knowledge tries to be an objective account of nature in addition for being "useful". This view has two dimensions if one attempts to locate it in terms of the systems postulated by the a-priori analysis: a pragmatic one and another shared by all of inductivism, hypothetico-deductivism and logical positivism.

E. Ontological question.

For the two groups of statements (24a,24b,24c and 25a,25b) which concern the issue of reality a statistically significant correlation exists (at 0.01 level of significance) and indeed it is rather strong (Cramer's V=0.63). The size of standardised residuals however does not indicate any particular pattern of association.

F. Assumptions about learning.

In this theme, of the three possible correlations, only one can be established. This correlation concerns the 28a,28b,28c and 33a,33b,33c groups of statements (at less than 0.01 level, Cramer's V=0.50)

33a,33b,33c / 28a,28b,28c	abstract thinking	prior knowledge	perception of self-need
rational understanding	-	+	
knowledge and skills	+	-	
formation of ind. view			

TABLE T8.37

From the above table T8.37, a pattern involving only two systems ("cognitivism" and "behaviourism") emerges. Thus, there is a clear association between aims of learning activities conceived as rational

VIII.7 THIRD STAGE: A STUDY OF CORRELATIONS.

This stage deals with an analysis of correlations. That is, the views of the respondants regarding each of the constituent themes (e.g. scientific methodology, the question of teaching integrated science or different scientific subjects, assumptions about learning etc.) of the three components of the instrument, are correlated in pairs within and across the three components.

The following table provides a summary of the cross-tabulation tables which are shown in Appendix 2, for each of the correlations found to be significant at least the 0.05 level. The correlation coefficients reported are Cramer's V [12].

The notation employed for the construction of this table is as follows:

for significance level

1 - 0.06	blank	(no evidence of correlation);
0.05 - 0.01	+	(evidence of correlation);
less than 0.01	*	(strong evidence of correlation).

A "qualitative" representation of the correlations between themes which are evident from table T8.24 is shown in the following figure F8.4.

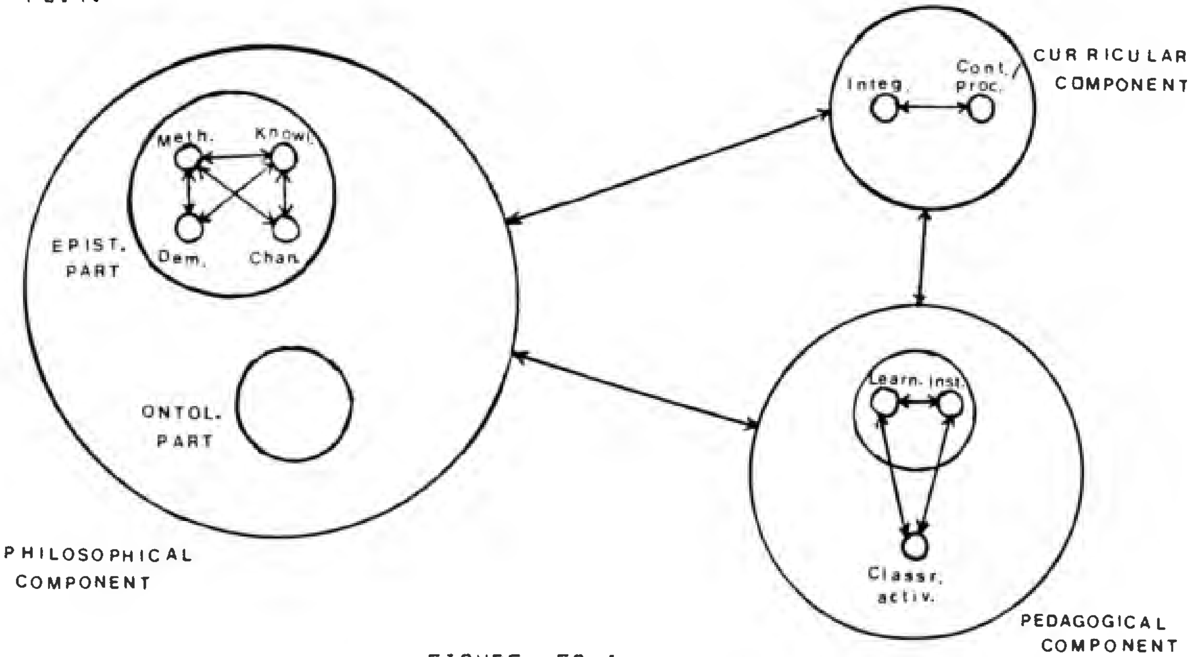


FIGURE F8.4

CORRELATIONS AMONG THEMES.

	Scient. Method.	Demarc. Criteria	Scient. Growth	Knowl. Status	Ontol. issue	Content-Process	Integrat. Science	Learning Assumpt.	Instruct. Assumpt.	Classroom Practice
Scientific Methodology	-	-	-	-	-	-	-	-	-	-
Demarcation Criteria	* 0.36	-	-	-	-	-	-	-	-	-
Scientific Growth	* 0.33		-	-	-	-	-	-	-	-
Status of Knowledge	+ 0.28	* 0.33	+ 0.30	-	-	-	-	-	-	-
Ontological question					-	-	-	-	-	-
Content-Process	* 0.36	* 0.38	* 0.33	* 0.41	* 0.34	-	-	-	-	-
Integrated Science	+ 0.27	* 0.29	* 0.40	* 0.31	+ 0.27	* 0.34	-	-	-	-
Learning Assumptions	* 0.33	+ 0.29	+ 0.31	* 0.27		* 036		-	-	-
Instruction Assumptions	* 0.47	* 0.50	* 0.36	* 0.38	+ 0.33	* 0.39	+ 0.34	* 0.40	-	-
Classroom Practice	+ 0.27			+ 0.27		* 0.36	* 0.31	+ 0.28	* 0.39	-

TABLE T8.38

Four points emerge:

-Firstly, the various themes are correlated significantly within and across components. Interestingly, the two themes of the curricular component are both related with every theme of both the philosophical and pedagogical components. The same applies for the assumptions about learning and assumptions about instructions of the pedagogical component, while assumptions about activities in classroom are related with the curricular component but only with scientific methodology in terms of the epistemological component. It is not surprising of course that the curricular and pedagogical components are more "integrated" than the philosophical -epistemological component.

-Secondly, scientific methodology and the status of scientific knowledge appear to constitute the poles of the epistemological component (i.e. they are correlated with every other theme of this component). This could be seen in the light of the outcome of the previous stage of the analysis (section VIII.6.3) according to which these two themes are the extreme points of the movement away from the traditional image of science (i.e. empirico-inductive) towards a more relativistic stance.

-Thirdly, views about the ontological question are correlated only with curricular views. Thus, it may be that it is not ontology which sustains teachers' epistemological beliefs, (though this does not mean that their views about the issue of reality lack educational interest).

-Fourthly, the existence of correlations between the curricular/pedagogical and philosophical components is of particular interest due to its educational implications and to the questions one can raise if an explanation is attempted. These points will be discussed later.

Having established the existence of correlations, the next step is to interpret them, in terms of which choices of positions systematically go together. In other words, to find out whether people, who according to the analysis thus far belong to a particular system (e.g. contextualism B) in terms of any of the themes of the epistemological component, subscribe to the same system (or if not, which system(s) they do accept) in the other themes with which this theme is correlated.

The correlation tables have many degrees of freedom. An effective way to report the nature of the correlation is to identify cells in which the model of no association leaves large standardised values. For this purpose, the standardised residuals are a good guide to the cells where the correlation largely arises. Standardised residuals having values larger than two standard deviations were first noted, with attention paid to cells with residuals larger than one standard deviation. An account of the statistical aspects of this analytical strategy is provided in Appendix I.

In the tables T8.40 to T8.75 in which the size of the standardised residuals are indicated for every cell the following convention is applied:

sr>1.90 or <-1.90	⊕ or ⊖ respectively;
1.90>sr>0.90 or -1.90<sr<-0.90	+ or - respectively;
sr between -0.90 and 0.90	blank.

TABLE T8.39

Large standardised residuals in cells with low frequencies were given less prominence, since they reflect the views of only a small fraction of the sample. In tables T8.40 to T8.74, columns with high frequencies are indicated by an asterisk.

In the following sections firstly the correlations within the components and then the correlations across the components will be discussed.

VIII.7.1 Correlations within components.

A. Philosophical component.

1. For the correlation between the themes concerning scientific methodology and criteria of demarcation (see table T8.40) the prominent features are that deductivists, in terms of scientific methodology, tend also to go for relativism with regard to the criteria of demarcation; that contextualists (version A and B) tend as well to see the choice between scientific theories as based on rational criteria, while the other stream stresses the notion of truth as a basis for this choice; and finally that "eclectics" in one theme appear to be "eclectics" in the other theme as well.

Furthermore, there is a clear - although not so strong as previously - tendency for people who support inductive reasoning, to subscribe to the view that the better of two competing theories is the one which arises from consensus among scientists and simultaneously gives the more useful results, while the same criteria for the choice of scientific theories are favoured by teachers who for the scientific method accept choice on a rational basis. Interestingly, all the people who appear to follow a clear-cut position in the theme of scientific methodology tend also to do so (i.e. not to have "eclectic" views) regarding the theme "criteria of demarcation".

2. In so far as the correlation between the themes of scientific methodology and patterns of scientific change is concerned (see table T8.41), inductivists (in scientific methodology) are divided between the Kuhnian (version B) and relativistic stances as to how science changes, being very rarely "eclectics". On the other hand, teachers who see the choice of the proper scientific method to be applied to a given problem as a "rational" exercise, seem to prefer the view that scientific knowledge changes through a succession of frameworks, some of which are incompatible with each other. Of interest here, amongst the less strong tendencies present, is the evidence that contextualists (of either version) regarding scientific methodology, espouse "eclectic" views concerning the pattern of scientific change, while

"eclectics" in the former theme become relativists in the latter.

3. The relationship between the themes of scientific methodology and the status of scientific knowledge, to be discussed now (see table T8.42), is of particular significance, since these two themes are related to the other philosophical themes (see figure F8.4). It reveals a tendency to philosophical consistency, at least amongst those who support a version of contextualism (rational grounds for choice of scientific method can be found), in that this view goes frequently with the view that scientific knowledge has some characteristics which make it particular and less frequently with other views. Inductivists in terms of scientific methodology, however, appear to switch to the position claiming that scientific knowledge does not differ from any other kind of organised knowledge, and not to be "eclectics". The "eclectics" are consistent in being "eclectic" both in methodology and about the status of scientific knowledge.

It may seem that the inductivists (within scientific methodology) are being philosophically inconsistent. That is, it appears uncomfortable to insist on the inductive ("data-driven") mode of reasoning while asserting that scientific knowledge has not special status vis-a-vis other forms of knowledge. Alternatively, if a particular form of reasoning, which emphasises the role of observation, is uniquely appropriate for the scientific enterprise, does not this mean that science is in one way or another distinct from organised knowledge which does not have this feature? A counter-argument, provided that one adopts a compatible stance at the ontological level (e.g. scepticism - see section III.6.4 for the relevant arguments), could be that the empirical-relativistic combination does not actually involve internal contradictions in principle. It should be noted, however that evidence of any such association with a compatible ontological system was not found.

4. The pattern in table T8.43 resembles the one concerning the correlation between the status of scientific knowledge and scientific methodology. Those who think that scientific knowledge is specially due to its usefulness as well as being a systematic pattern of thought, also tend to understand the choice between scientific theories as made on the basis of rational criteria (even if they hesitate to grant any

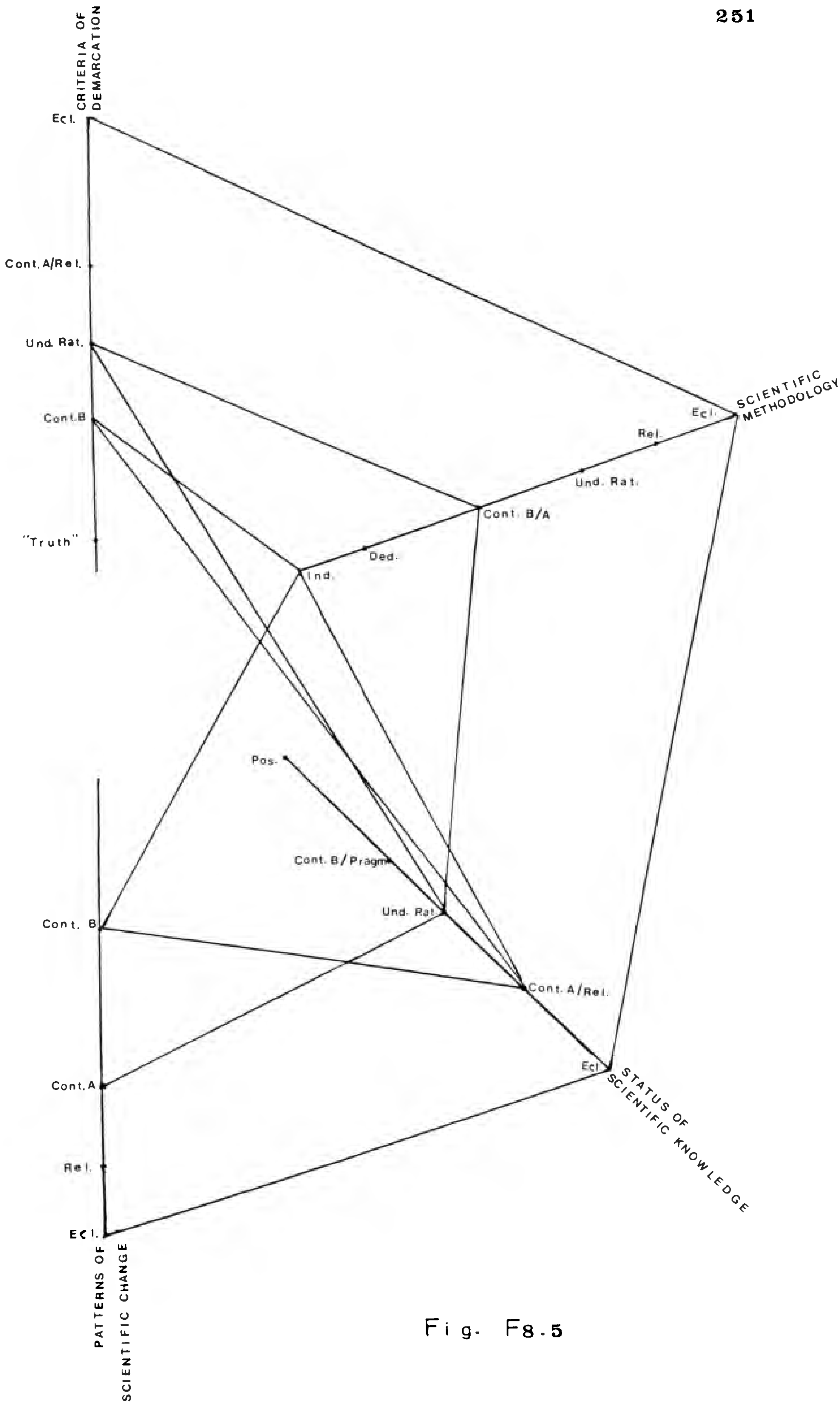
priority to a certain notion, e.g. truth, usefulness, consensus of the relevant scientific community). The same remark (the effect however as indicated in table T8.43 is less strong) applies to the category of undecided rationalists in terms of scientific knowledge. In marked difference the relativistic streams on one theme have a tendency to choose a similar view regarding the other theme which makes the overall pattern much more consistent than the one concerning the correlation between scientific methodology and the status of scientific knowledge.

5. The last element of the epistemological component is the correlation between the themes of the status of scientific knowledge and pattern(s) of scientific change (see table T8.44). Here, the strongest effect is the convergence of undecided rationalists in terms of scientific knowledge with contextualists (version A). Otherwise, both relativists and "eclectics" in one theme tend to opt for the same category in the other theme.

6. As shown in table T8.38 the ontological question is not correlated significantly with any of the other themes of the epistemological-philosophical component. A very weak correlation appears to exist only with the theme of criteria of demarcation. As noted before the only themes with which teachers' views about reality correlate are those referring to curricular issues (meaning of content and process in science teaching the question of integrated science). Thus, it appears that teachers' views on this, despite the fact that they do not provide the linkage between the various elements of their epistemological views as was initially hypothesised, nevertheless have their educational implications. These implications will be discussed later.

To conclude the discussion about the epistemological component, an attempt will be made to bring together the associations which point to systematic patterns amongst the various relationships just described. The following tendencies can be discerned:

a. Inductivists with regard to scientific methodology are associated with contextualism B (criteria of demarcation), contextualism B in terms of the theme "patterns of scientific change" and finally their views seem to be correlated with contextualism A/relativism concerning the status of scientific knowledge. Their views



CRITERIA OF DEMARCATION
Ecl.
Cont. A/Rel.
Und. Rat.
Cont. B
"Truth"
SCIENTIFIC METHODOLOGY
Ecl.
Rel.
Und. Rat.
Cont. B/A
Ded.
Ind.
Pos.
Cont. B/Pragm.
Und. Rat.
Cont. B
Cont. A/Rel.
Ecl.
STATUS OF SCIENTIFIC KNOWLEDGE
Cont. A
Rel.
Ecl.
PATTERNS OF SCIENTIFIC CHANGE

Fig. F8.5

in the latter theme appear to be correlated with contextualism B in so far as the criteria of demarcation are concerned.

b. People who tend to subscribe to contextualism B/A for the theme of scientific methodology also tend to opt for the category of undecided rationalists in terms of both criteria of demarcation and the status of scientific knowledge. It is worthnoting that the latter two categories are associated with each other. Lastly undecided rationalists (status of scientific knowledge) are inclined towards contextualism A (patterns of scientific change).

c. Eclectics in terms of scientific methodology tend to be "eclectics" in both the criteria of demarcation and the status of scientific knowledge. Furthermore, "eclectics" in the latter theme incline to be "eclectics" regarding patterns of scientific change. The above associations are reflected by figure F8.5.

This analysis seems to corroborate the findings of the previous stage of analysis (section VIII.6.3). According to these findings as one moves successively from the theme of scientific methodology, to criteria of demarcation, pattern(s) of scientific change, to end up with the status of scientific knowledge, a gradual shift away from systems in which science is envisaged as "rational" enterprise towards more relativistic stances occurs.

One could proceed with the above conclusions one step further. It could be argued that two groups of people (three if one takes into account "eclectics") can be distinguished, as shown below.

	Scientific Methodology	Criteria of Demarcation	Patterns of sc. change	Status of Knowledge
1st group	Inductivism	Contextualism B	Contextualism B	Context A/Relat.
2nd group	Contextualism B/A	Und. Rational.	Contextualism A	Und. Rational.

TABLE T8.75

The existence of such distinctive groups could be tested, in principle, by a multi-variate correlational analysis.

Furthermore, if one sees this hypothesis in the light of the data concerning the differentiation of views according to the subject of specialisation ie. physics, chemistry and biology (see section VIII.6.1, tables T8.22 to T8.25) it becomes clear that a further hypothesis can be put forward. It appears that biology teachers are mostly close to the first of the above proposed groups, physics teachers to the second group, while chemistry teachers tend to fall within "eclecticism".

B. Curricular component.

7. The two themes which constitute the curricular component, as indicated by table T8.38, are correlated at 0.01 level of significance. In interpreting this correlation four groups of people can be discerned (see table T8.45). Two of these groups arise out of the association of categories with a considerable following, whilst the sources of the other two are categories of limited popularity.

1st group	content and process conceptually related; content - facts, process - methodological considerations. for integrated science; justification: practical reasons.
2nd group	content and process conceptually related; content - facts, process - experimentation techniques. for integrated science; justification: similarities in content and methods, social relevance.
3rd group	content and process are not related conceptually; content - facts, process - methodological considerations. for separate subjects; justification: differencess in content, practical reasons.
4th group	content and process are not related conceptually; content - facts, process - experimentation techniques. for separate subjects; justification: differencess in methods, social relevance.

TABLE T8.76

C. Pedagogical component.

8. As shown in table T8.46 the cognitive stream (assumptions about learning) tend to think best of a balanced approach (neither objectives-oriented nor teacher-centred) in instruction, that knowledge should be presented in small steps, reject the view that reinforcement is irrelevant to teaching and finally are divided between considering active participation on the part of students and students' emotional involvement as the crucial factors for motivation. "Behaviourists" rather predictably seem to share the preference for the first two of the above elements whilst envisaging reinforcement as an integral part of teaching and learners' participation as an essential factor for motivation. Lastly "constructivists" seem to think that the features of a reasonable approach to instruction are a balanced approach, presenting the whole idea firstly and proceeding to the elaboration of the particulars, motivation based on pupils' emotional involvement and rather surprisingly see reinforcement as an essential part of the teaching procedure.

9. The interpretation of the correlation between the themes "assumptions about learning" and "classroom activities" reveals a rather straightforward pattern (see table T8.47). The indications are that "cognitivists" prefer the flow of knowledge to be controlled by the teacher, believing however that a "good" teacher has to focus on pupils' decisions and understand of pupils' thinking. "Behaviourists" on the other hand tend to take a reverse view judging the qualities of teacher in terms of his/her effective teaching techniques and mastery of the subject, while their attitudes appear to favour pupils' involvement in the exchange of knowledge taking place in classrooms. Followers of the last system ("constructivism"), given the emphasis this system puts on the self-construction of knowledge by individuals, quite consistently lean strongly towards a pupil oriented view regarding both elements (knowledge management and traits of successful teacher).

10. The pattern one gets from looking at the correlation between "assumptions about instruction" and "assumptions about classroom

activities" is not as clear as the previous ones (see table T8.48). Nevertheless, teachers who tend to believe that the control of the classroom communication system should be with themselves, while considering that the teacher should take into account pupils' decisions and pupils thinking in conducting a lesson tend to prefer instruction in terms of a balanced orientation, presentation of knowledge in small steps, attach primary importance in reinforcement and value the emotional aspects of motivation. This is quite consistent with what the above two patterns revealed (i.e. both the above described elements are associated with cognitivism, see tables T8.46 to T8.47). Teachers who are inclined to keep for themselves the control of flow of knowledge but emphasise the understanding of pupils' thinking and respect of pupils' decisions as crucial traits of a "successful" teacher (pupil-teacher centred approach), as far as the two elements of "classroom activities" are concerned, are associated with behaviourism (see table T8.47). Subsequently, behaviourists' views which in turn are associated with balanced approach, presentation of knowledge in small steps, stress on emphasis of the role of reinforcement and pupils' participation (see table T8.46), have in this instance the tendency to opt for a balanced approach, presentation of the whole idea, pupils participation and only occasional use of reinforcement. Finally, the "pupil-pupil" centred stream does not choose any of the categories with wide following regarding the theme concerning instruction.

In all, it could be argued that three distinct groups are emerging from the analysis of the pedagogical component. These groups are:

1st group
a. "cognitivism";
b. balanced orientation, presentation of knowledge in small steps, reinforcement integral part of instruction, motivation based on emotional involvent (BO-ST-EM-IN);
c. teacher (knowledge)-pupil (traits of teacher) centred activities in classroom.

2nd group
a. "behaviourism";
b. pupil (knowledge)-teacher (traits of teacher) centred activities in classroom; (no association with any particular stance with regard to instruction).

3rd group
a. "constructivism";
b. pupil (knowledge)-pupil (traits of teacher) centred activities in classroom; (no association with any particular stance with regard to instruction).

TABLE T8.77

METHODOLOGY \ DEMARCATION	truth	* cont. B/pragm.	und. rat.	cont. A/rel.	* ecl.
* ind.		+	−		−
ded.	+	−		⊕	−
* cont. B/cont. A	⊕	−	⊕	−	−
und. rat.	−	+	−		
* ecl.	−				⊕

T8.40

METHODOLOGY \ CHANGE	ind.	* cont. B	* cont. A	rel.	* ecl.
* ind.		⊕	−	⊕	⊖
ded.	+	+	−		
* cont. B/cont. A		−			+
und. rat.	−		⊕	−	
* ecl.		−		+	

T8.41

METHODOLOGY \ KNOWLEDGE	pragm./cont. B	* und. rat.	* rel./cont. A	* ecl.
* ind.		−	+	⊖
ded.		−		
* cont. B/cont. A	+	⊕	−	−
und. rat.	−	+	−	
* ecl.		−		+

T8.42

DEMARCATION \ KNOWLEDGE	pragm./cont. B	* und. rat.	* rel./cont. A	* ecl.
truth				
* cont. B/pragm.			−	+
und. rat.	⊕	+	−	−
cont. A/rel.	−	−	+	−
* ecl.				

T8.43

CHANGE \ KNOWLEDGE	cont. B/pragm.	* und. rat.	* rel./cont. A	* ecl.
ind.				
* cont. B	−	−		
* cont. A		⊕		−
rel.			+	
* ecl.	+			+

T8.44

CONTENT/PROCESS \ INTEGRATION		int.: * cont. + meth. + soc. rel.	int.: * pract.	sep.: * cont. + pract.	sep.: else	other
rel.	laws + exp.	+	−	−		
	facts + meth.		+	−		
	* facts + exp.	+	−			−
dist.	* facts + exp.	−	+		⊕	−
	facts + meth.	−		+	−	−
other				+		

T8.45

LEARNING \ CLASSROOM ACTIVITIES	* teach.-teach.	* teach.-pup.	pup.-teach.	* pup.-pup.	other
* cogn.		+	−		
beh.			+		
constr.	−		+	⊕	
* other	+				+

T8.47

INSTRUCTION \ LEARNING	* cogn.	beh.	constr.	* other
TO-ST-AP-OC	−		−	+
BO-ST-AP-IN		⊕		−
BO-ST-AP-OC	⊕	−		−
BO-ST-EI-IN	⊕	−	−	
BO-ST-EI-OC			+	
BO-WI-AP-OC	−			
BO-WI-EI-IN	−	+	⊕	−
other	−			+

T8.46

INSTRUCTION \ CLASSROOM ACTIVITIES	* teach.-teach.	* teach.-pup.	pup.-teach.	* pup.-pup.	other
TO-ST-AP-OC	+	−		−	⊕
BO-ST-AP-IN					
BO-ST-AP-OC			−		
BO-ST-EI-IN	−	⊕	−		
BO-ST-EI-OC	+	−			
BO-WI-AP-OC			⊕	−	
BO-WI-EI-IN	−	+			
other		−		+	

T8.48

CONTENT/PROCESS \ METHODOLOGY	* ind.	ded.	* cont.B/cont.A	und. rat.	* ecl.
rel.-laws-exp.			−	⊕	
* rel.-facts-meth.	−	−		−	+
* rel.-facts-exp.	⊕	+	−		−
dist.-facts-exp.	−			−	+
dist.-facts-meth.	−		+	+	−
other				−	+

T8.49

METHODOLOGY \ INTEGRATION	* sep.-cont.-pract.	sep.-else	* int.-c.-m.-sr.	* int.-pract.	other
* ind.		+		−	
ded.	−			⊕	
* cont.B/cont.A		−		+	
und. rat.			+	−	−
* ecl.					

T8.50

CONTENT/PROCESS \ DEMARCATION	truth	* cont.B/pragm.	und. rat.	cont.A/rel.	* ecl.
rel.-laws-exp.		−			⊕
* rel.-facts-meth.	+	−			
* rel.-facts-exp.	−	+	−	+	
dist.-facts-exp.	−	−	⊕	−	
dist.-facts-meth.		+	⊕	−	⊖
other	+		−		

T8.51

CONTENT/PROCESS \ CHANGE	ind.	* cont.B	* cont.A	rel.	* ecl.
rel.-laws-exp.		−	⊕		−
* rel.-facts-meth.					
* rel.-facts-exp.	+	+	⊖	+	
dist.-facts-exp.			+		−
dist.-facts-meth.	−	⊖	+		+
other	−				⊕

T8. 52

DEMARCATION \ INTEGRATION	* sep.-cont.-pract.	sep.-else	* int.-c.-m.-sr.	* int.-pract.	other
truth		−		+	−
* cont.B/pragm.	+		−	−	+
und. rat.	+		−	⊕	−
cont.A/rel.			−		
* ect.	−	+	⊕	−	

T8.53

CHANGE \ INTEGRATION	* sep.-cont.-pract.	sep.-else	* int.-c.-m.-s.r.	* int.-pract.	other
ind.	−		+		+
* cont.B	−	⊕	+		−
* cont.A	+	−		+	
rel.	−		−	−	⊕
* ecl.	⊕	−			

T8. 54

KNOWLEDGE \ INTEGRATION	* sep.-cont.-pract.	sep.-else	* int.-c.-m.-s.r.	* int.-pract.	other
pragm/cont.B	⊕			−	−
* und.-rat.		−		⊕	−
* rel./cont.A	−				+
* ect		+		−	−

T8.55

KNOWLEDGE \ CONTENT/PROCESS	rel.-laws-exp.	* rel.-facts-meth.	* rel.-facts-exp.	dist.-facts-exp.	dist.-facts-meth.	other
pragm./cont.B		−			⊕	
* und.-rat.			⊖	⊕	⊕	+
* rel./cont.A	+	+	+	−	⊖	−
* ecl.	−	−		+		+

T8.56

CONTENT/PROCESS \ ONTOLOGY	pragm.	* sc. real.	* ideal.	scept.	* ecl.
rel.-laws-exp.		−	−		⊕
* rel.-facts-meth.			⊖	+	+
* rel.-facts-exp.			+		
dist.-facts-exp.		⊕	−		−
dist.-facts-meth.	⊕				
other			+		−

T8.57

ONTOLOGY \ INTEGRATION	* sep.-cont.-pract.	sep.-else	* int.-c.-m.-sr.	* int.-pract.	other
pragm.	+				
* sc. real.	+		−		
* ideal.	−	−	+	+	−
sceptic.	−		+		
* ecl.				−	⊕

T8.58

LEARNING / METHODOLOGY	* cogn.	beh.	constr.	* other
* ind.	⊕		−	−
ded.	+		+	−
* cont. B/cont. A	−	+	−	+
und. rat.	−		+	
* ecl.				

T8.59

LEARNING / DEMARCATION	* cogn.	beh.	constr.	* other
truth	−	+		
* cont. B/pragm.	+	−	−	
und. rat.	−	⊕		
cont. A/rel.	+		−	
* ecl.		−	+	

T8.60

LEARNING / CHANGE	* cogn.	beh.	constr.	* other
ind.		+		
* cont. B	+		−	
* cont. A			+	
rel.	+			
* ecl.	−		+	

T8.61

LEARNING / KNOWLEDGE	* cogn.	beh.	constr.	* other
pragm./cont. B	−	⊕	−	
* und. rat.	−			+
* rel. / cont. A				
* ecl.		−		

T8.62

CLASSROOM ACTIVITIES / METHODOLOGY	* teach. -teach.	* teach. -pup.	pup. -teach.	* pup. -pup.	other
* ind.		+	−	−	+
ded.	−	⊕			
* cont.B / cont.A					
und. rat.		−	⊕		
* ecl.		−			

T8.63

CLASSROOM ACTIVITIES / KNOWLEDGE	* teach. -teach.	* teach. -pup.	pup. -teach.	* pup. -pup.	other
pragm. / cont.B					
* und. rat.		+		−	
* rel. cont.A	−			+	
* ecl.	⊕	⊖			

T8.64

INSTRUCTION / METHODOLOGY	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
* ind.	−		⊕	+	−	−		−
ded.				⊕		−	⊕	−
* cont.B / cont.A	−	⊕	−	−	−	+		+
und. rat.	⊕	−			⊕	+		−
* ecl.		−			+			+

T8.65

INSTRUCTION / DEMARCATION	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
truth		−		−	−	+	⊕	+
* cont.B/pragm.	+		+		⊕		−	−
und. rat.		⊕	−	−	−	−		
cont.A/rel.		−		⊕	−	−		
* ecl.		⊖				+		+

T8.66

INSTRUCTION / CHANGE	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
ind.				−	−			+
* cont.B	+		+	⊕	−	−		−
* cont.A	−	⊕	−	−	⊕	+		
rel.	+		⊕					−
* ecl.	−		−				+	+

T8.67

KNOWLEDGE \ INSTRUCTION	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
pragm./ cont. B		⊕		−	−			
* und. rat.	−	+	−	−	+	+		
* rel. /cont. A	−	−		+	−			
* ecl.	⊕	−	+	−				

T8.68

ONTOLOGY \ INSTRUCTION	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
pragm.					⊕			
* sc. real.				−	+			
* ideal.	+	−		⊕	−			
scept.		+			⊕			−
* ecl.		+			−			

T8.69

CONTENT/ PROCESS \ LEARNING	* cogn.	beh.	constr.	* other
rel.- laws- exp.			⊕	−
* rel.- facts- meth	−	+	+	
* rel.- facts- exp.	⊕	−	⊖	
dist.- facts- exp.		−		
dist.- facts- meth.	−	+		
other	−			

T8.70

CONTENT/ PROCESS \ INSTRUCTION	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
rel.- laws- exp.						⊕		
* rel.- facts- meth.		−	−					+
* rel.- facts- exp.	+		⊕	+	⊖	−		
dist. facts- exp.		⊕	+	−	−			−
dist. facts- meth.		⊕	−	−	⊕	−	+	
other		−	−		⊕			+

T8. 71

CONTENT/ PROCESS \ CLASSROOM ACTIVITIES	* teach. -teach.	* teach. -pup.	pup. -teach.	* pup. -pup.	other
rel.- laws- exp.	−	−	⊕		
* rel.- facts- meth.		−		⊕	
* rel.- facts- exp.		+	−	−	+
dist.- facts- exp.				−	
dist.- facts- meth.	+		−		
other					

T8. 72

INTEGRATION \ CLASSROOM ACTIVITIES	* teach. -teach.	* teach. -pup.	pup. -teach.	* pup. -pup.	other
* sep.- cont.- pract.	⊕	−	−	−	
sep.- else		−			⊕
* int.- c. m. - s. r.	−		+	+	
* int.- pract.	−	⊕		−	
other	−		+		

T8. 73

INTEGRATION \ INSTRUCTION	TO-ST-AP-OC	BO-ST-AP-IN	BO-ST-AP-OC	BO-ST-EI-IN	BO-ST-EI-OC	BO-WI-AP-OC	BO-WI-EI-IN	other
* sep.- cont.- pract.	−			−	⊕		+	−
sep. - else		+	+	+	−	−		
* int. - m. - s. r.	+	−			−	+		
* int. - pract.	−	+	−	+		−		+
other		−						

T8. 74

VIII.7.2 Correlations across components.

A. Philosophical-curricular components.

As shown in table T8.38, the two themes which constitute the curricular component are correlated significantly with every theme of the philosophical-epistemological component.

11. Methodological considerations appear to be of some importance in the meaning of the terms content and process in science, while such considerations tend to play a lesser role in teachers' decisions about solving the dilemma between teaching integrated science as opposed to different subjects (table T8.49). Thus, inductivists see scientific content as pertinent to "facts" and define process as experimentation techniques. People who with regard to methodology follow either version of contextualism, seem to object to such an interpretation of process, envisaging it mainly as concerned with methodological issues.

12. The pairs of tables T8.51, T8.52 and T8.53, T8.54 concern the correlations between themes of the curricular component and teachers' views about criteria of demarcation and pattern(s) of scientific change respectively.

These tables suggest that teachers who believe that scientific content and process are closely related conceptually and understand content as "facts" and process as experimentation techniques, tend to subscribe to the second version of contextualism for both of the above epistemological themes (see tables T8.51 and T8.52). On the other hand, people who tend to attach facts to content and methodological considerations to scientific process oppose contextualism B /Pragmatism (for the criteria of demarcation) and express no preference for the way science changes or develops.

Secondly, with regard to the question of how to organise the teaching of science (integrated science v.s. separate subjects), interestingly, teachers who base the choice between competing scientific theories on the notion of truth, appear to prefer the teaching of integrated science, justifying this choice on the grounds of practical considerations (see table T8.53). Others for whom the basis of demarcation is the consensus of the relevant scientific community and the "usefulness" of a certain scientific theory, seem to advocate the teaching of separate scientific subjects because of the difference in their content and for practical reasons.

Furthermore, teachers who subscribe to a more "rationality bound" version of contextualism (with regard to the pattern of scientific change) present a tendency to accept integrated science on the basis of similarities in content and methods, as well as to see this option of the science curriculum in schools as contributing to make scientific knowledge relevant to the pupils (see table T8.54). On the contrary, the more relativistic interpretation of the Kuhnian system (contextualism A) is divided between teaching separate scientific subjects (for reasons of differences in content and expediency) on the one hand and offering an integrated science curriculum, mainly for practical reasons, on the other.

13. Concluding the discussion of the interpretation of the correlations between the epistemological and curricular components, it could be noted that teachers who believe that scientific knowledge is privileged vis-a-vis other forms of knowledge but are undecided as to why this is the case (undecided rationalists), lean strongly towards the teaching of integrated science having taken into account practical constraints (see table T8.55). The same group seems to strongly oppose the definitions of scientific content as "facts" and scientific process as experimentation techniques. Relativists, as far as the status of scientific knowledge is concerned, see content and process as conceptually related, interpret content as "facts" but they are undecided on what the meaning of scientific process is, being divided between methodological considerations and experimentation techniques (see table T8.56).

14. If the above attempt to interpret the correlations between the epistemological and curricular components results in a somewhat fragmented pattern, surprisingly a much clearer pattern concerning the correlations between teachers' views on the ontological question and

their views about science curriculum emerges (given the fact that the issue of reality does not appear to correlate significantly with the epistemological themes). Thus, there is a simple tendency for each ontological position to go with a single (empirically found) pattern of beliefs about the relation and the meaning of the terms content and process in science (tables T8.57 and T8.58). This correspondence is as follows:

Ontological positions	Meaning of content and process in science
Scientific Realism	content and process conceptually distinct content - facts process - experimentation techniques.
Idealism	content and process conceptually related content - facts process - experimentation techniques.
Scepticism	content and process conceptually related content - facts process - methodological considerations.
Pragmatism	content and process conceptually distinct content - facts process - methodological considerations.

NOTE: The first and fourth groups are of very limited interest because of the low frequencies involved (see table T8.26).

TABLE T8.78

It is also worth noting that eclectics with regard to ontology appear to prefer the view that scientific content and process are conceptually related and attach the meaning of scientific laws to the scientific content and the meaning of experimentation techniques to scientific processes (see table T8.57).

15. As far as the correlation between the themes of ontology and

integrated science curriculum is concerned, the pattern emerging is not so clear (see table T8.58). In this case, the significant effects can be summarised as follows:

Ontological positions	Question of integration
Scientific Realism	teaching of separate scientific subjects justification: differences in content, practical reasons.
Pragmatism	teaching of separate scientific subjects justification: differences in content, practical reasons.
Scepticism	teaching of integrated science justification: similarities in content and in methods, social relevance.

NOTE: Only the first group is of interest in terms of frequencies involved (see table T8.26).

TABLE T8.79

Teachers who appear to follow idealism are for the teaching of integrated science, but are split in two when the question of the justification of their preferences arises. On the one hand, there are people who consider integrated science convenient for practical reasons and on the other hand people who ground their preference on epistemic-sociological considerations (similarities in content and method, making science socially relevant).

Finally, eclectics about ontology do not subscribe to any of the previously mentioned groups with regard to the question of integrated science (see table T8.58).

B. Philosophical-Pedagogical components.

16. The outcome of the interpretation of the statistically significant correlations between the epistemological and pedagogical components (shown in table T8.38) will be presented in a tabular form (tables T8.75, T8.76 and T8.77) given the large number of categories included in each of the themes of these components. In these tables,

for every category of the themes constituting the pedagogical component, the epistemological system for which a preference is detected will be indicated (from tables T8.59 to T8.69)

LEARNING ASSUMPTIONS - EPISTEMOLOGY ASSOCIATION.

	Scientific Methodology	Criteria of Demarcation	Patterns of sc. change	Status of Knowledge
Cognitivism	Inductivism	Contextualism B/A	Contextualism B	
Behaviourism	Contextualism B/A	"Truth"	Inductivism	Contextualism B
Constructivism	Contextualism B/A	Eclecticism	Context. A/Eclecticism	

TABLE T8.80 (based on tables T8.59 to T8.62)

CLASSROOM ACTIVITIES - EPISTEMOLOGY ASSOCIATION.

	Scientific Methodology	Criteria of Demarcation	Patterns of sc. change	Status of Knowledge
teacher-pupil centred	Inductivism	Undecided Rationalists		
pupil-teacher centred	Undecided Rationalists			
pupil-pupil centred		Relativism		

TABLE T8.81 (based on tables T8.63 and T8.64)

Seeing the above two tables in conjunction with table T8.75, it is not possible to match the two groups described in table T8.75 in any simple way with the groups identified above. This is not to say however that a pattern cannot be established. Let us accept that the interpretation of "rationality" changes (from a set of a-historical, timeless criteria to a completely relativistic conception) as one moves from inductivism to relativism. It then becomes clear that according to the evidence, as one moves from knowledge or skills centred systems to constructivism (theories of learning), or from more traditional approaches in terms of control of classroom activities, one also changes perspective in the way the role of rationality is conceived epistemologically (from inductivism to relativism).

INSTRUCTION ASSUMPTIONS - EPISTEMOLOGY ASSOCIATION.

	Scientific Methodology	Criteria of Demarcation	Patterns of sc. change	Status of Knowledge
TO-ST-AP-OC	Und. Rational.	Context. B/Pragm.		Eclectics
BO-ST-AP-IN	Context. B/A	Und. Rational.	Contextualism A	Context. B/Pragm.
BO-ST-AP-OC	Inductivism	Context. B/Pragm.	Relativism	Eclectics
BO-ST-EI-IN	Ind./Ded.	Context. A/Relat.	Contextualism B	Context. A/Relat.
BO-ST-EI-OC	Und. Rational.	Context. B/Pragm.	Contextualism A	Und. Rational.
BO-WI-AP-OC			Context. A	Und. Rational.
BO-WI-EI-IN	Deductivism	"Truth"	Eclectics	

The reference for the abbreviations applied in this table are the same as in section VIII.6.1.2 and can be found in table T8.30

TABLE T8.82 (based on tables T8.65 to T8.69)

The almost even distribution of responses regarding teachers' assumptions about instruction (the situation changes considerably if one takes into consideration factors like the subject of specialisation and the P.G.C.E students-practising teachers distinction, see table T8.30) seems to be the reason why it is not possible here to establish a pattern as meaningful as the previous one. On the other hand, given the size of the population it is not reasonable to run a test in which these differentiating factors are taken into consideration.

C. Curricular-Pedagogical components.

17. A tentative map of associations will be presented here, again in the form of a table. This table refers to the correlation between the meaning of the terms content and process in science on the one hand and the pedagogical component on the other. Table T8.83 points out the essential features of tables T8.70 to T8.72, taken together.

It should be clarified that in the following table an empty cell means either no association or associations of equal strength with more than one category.

CONTENT & PROCESS - PEDAGOGICAL ASSUMPTIONS ASSOCIATION.

	Assumption on learning	Assumption on instruction	Assumption on classroom activities
content-process related content - facts process - methodology	cognitivism	other stances	pupil-pupil
content-process related content - facts process - experimentation techniques		other stances	

TABLE T8.83 (based on tables T8.70 to T8.72)

Applying the same convention as above for the correlations between the theme of integrated science and the pedagogical component the interesting element which comes out is the association between the views of people who are inclined to prefer the teaching of integrated science for practical reasons and the "teacher-pupil" approach in terms of classroom activities (see tables T8.73 and T8.74).

For the interpretation of the findings summarised above, one should bear in mind that:

a. there is evidence of interaction between epistemological and pedagogical views (see tables T8.80 and T8.81) while no such correlations can be established between the ontological and the pedagogical views (see tables T8.38).

b. On the contrary, it appears that teachers' views about the curricular issues under consideration are associated with their views about the issue of reality (see tables T8.78 and T8.79) while their pattern of association with the epistemological component appears fragmented [see section VIII.7.2(13)].

c. Furthermore surprisingly, teachers' epistemological (level III) and ontological (levels I and II) views are not correlated (see table T8.38).

It seems reasonable therefore to hypothesise that there exist two relatively autonomous regions i.e. epistemological and pedagogical interrelated elements on the one hand and ontological - curricular one the other which constitute parts of the "educational" theory science teachers hold.

VIII.8 Reliability and validity.

Classical item analysis deals with tests consisting of several items set up to measure an ordinal variable (e.g. attainment in some ability). Thus, one can either compare the mean scores of the items, intended to measure the same attribute for the whole population (validity), or compare the mean score on each item amongst different target populations (reliability) [13]. This classical approach, however, does not fit well with the analytical problems of this thesis.

The research instrument is large (due to the attempt to cover an extensive area). For this reason no additional items were included in order to check the same attribute, so as to to make possible the quantification of the validity. However, as Northop [14] argues one can use the term validity referring to the "appropriateness" of operational definitions. Appropriateness, in this instance as Blalock [15] maintains, means the fitness of the operational definitions to the theoretical analysis, which "must inevitably be judged on the basis of one's understanding of the theoretical definitions". According to this argument, considering that the operational definitions are represented by sets of distinctions as organised in the form of systemic networks, the validity of the instrument depends on the adequacy of the analysis (chapters II and III) preceded the construction of the network (chapter IV) to dissect out consistent positions.

With regard to reliability Guilford and Fruchter [16] draw our attention to the fact that one should not speak of reliability of the measuring instrument but rather of reliability of measurements. Here however, the necessary assumption for the reliability test (i.e. that the distribution of responses regarding a certain attribute is identical for different sub-groups), is not held. On the contrary, the various sub-groups of the population are treated as distinct variables.

Nevertheless, there is an aspect of the reliability test which warrants some comment. Blalock [17] writes: "Since all measurement involves classification as a minimal requirement, an operational definition can be considered to be a detailed set of instructions enabling one to classify individuals unambiguously. The notion of reliability is thus built into this conception of the operational definition. The definition should be sufficiently precise that all persons using the procedure will achieve the same results". Clearly, the term 'same' is used here in the sense of results being free of procedural distortion. In terms of this, it can be argued that the systemic network, on the basis of which the instrument was constructed and which subsequently was the basis for the analysis of data, lays down very precise rules as far as the categorisation of respondents' views is concerned. These rules are made explicit in the second stage of the data analysis (tables T8.22 to T8.31-specification of the positions).

BIBLIOGRAPHICAL NOTES.

[1]. Niew, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., Bent, D. H. (1975);
Hull, C. H., Niew, N. H. (1981).

[2]. The majority of the examples used by Kuhn, for instance, are taken from history of physics.

[3]. Dibbs, D. R. (1982).

[4]. Ibid., p. 141.

[5]. Ogunniyi, M. B. (1982).

[6]. Rowell, J. A. and Cawthron, E. R. (1982).

[7]. Ibid.

[8]. Newton-Smith, W. H. (1981), chapter V.

[9]. Ziman, J. M. (1968).

[10]. Niew, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., Bent, D. H. (1975);
Hull, C. H., Niew, N. H. (1981).

[11]. Blalock, H. M. (1979), pp. 405-409.

[12]. Ibid., pp. 303-307.

[13]. Guilford, J. P. and Fruchter, B. (1981), chapters 17-18.

[14]. Northrop, F. S. C. (1947), chapters 5-7, cited in H. M. Blalock (1979).

[15]. Blalock, H. M. (1979), p. 13.

[16]. Guilford, J. P. and Fruchter, B. (1981), chapter 17.

[17]. Blalock, H. M. (1979), p. 12.

IX. DISCUSSION OF CONCLUSIONS AND THEIR IMPLICATIONS. SUGGESTIONS FOR FURTHER RESEARCH.

IX.1 A brief narrative: The study.

This piece of research sought to capture how science teachers and student teachers view scientific knowledge from a philosophical -epistemological perspective (the dimensions under discussion being scientific method, criteria of demarcation, patterns of scientific growth, issues concerning the theory-observation distinction and the related problems which deal with the construction of reality). These issues are seen as important since a well-developed philosophical standpoint can greatly enhance an adequate understanding of science. On this basis the investigation from the above perspective is followed by an attempt to investigate the link between these dimensions and a number of curricular and pedagogical issues pertaining to science education.

In terms of structure, commencing with the rationale and delineation of the main questions of the research, the study examined a number of theoretical systems, which constitute the philosophical basis of scientific knowledge and certain relevant curricular and pedagogical issues. There followed a discussion of methodological issues, the foci being on systemic network analysis technique and a framework for the location of pieces of relevant research. The latter framework was subsequently employed for an overview of the relevant literature while the systemic network analysis technique served as a means to organise the construction of the research instrument, discussed in chapter VII. The main advantage of the systemic network analysis (used here in a different fashion than that for which it was originally introduced) may lie in that in principle, it facilitates making explicit the choices and distinctions made, in a flexible but well defined way. Chapter VIII dealt with the analysis and interpretation of the empirical evidence; the present chapter reviews the overall conclusions.

IX.2 The conclusions: Recounting and discussing.

The aim is to bring together the specific conclusions drawn in the course of the analysis of the data. The chapter concludes with an overview of the main results and some remarks about further research.

A. Philosophical-epistemological views: Image of science.

1. Teachers do seem to have discernible views about the philosophical and epistemological basis of scientific knowledge, at least as far as the dimensions considered in this thesis are concerned. This corroborates previous findings e.g. Dibbs [1]. It should be noted however that despite both a number of studies which aver that teachers have such an interest, and arguments that a philosophical analysis of scientific knowledge is essential in science teaching, a general feeling appears to persist that teachers' interests are remote from such considerations.

2. The assertion that teachers have philosophical and epistemological views does not mean that they fully subscribe to one of the "orthodox" philosophical systems. As shown in section VIII.5 a dominant pattern for the whole sample can be discerned. The elements of this pattern, which resembles the second version of contextualism, are as follows:

-there are rational criteria regarding the choice of scientific methods and theories and a good guide for such choices is the consensus of the relevant community;

-scientific knowledge is not special but it has some particular characteristics in that it is a systematic and useful pattern of thought.

This result is, however, only an estimation of the "collective" view of many individuals and does not yet show whether or not teachers follow (in terms of any particular theme) any consistent system.

3. For this reason, in addition to the above analysis of the data, the responses in terms of groups of statements (which correspond to distinct conceptual themes) of each individual were analysed (sections VIII.6.1 and VIII.6.2). From this treatment of the data concerning the

themes of the philosophical-epistemological component, the following tendencies emerge:

THEME	MOST FAVOURED SYSTEM	LEAST FAVOURED SYSTEM
Scientific Methodology	Contextualism B/A	Relativism
Criteria of Demarcation	Context. B/Pragm.	Undecided Rationalists
Pattern(s) of sc. change	Contextualism B	Hyp.-Deductiv. and Relativism
The status of sc. knowledge	Context. A/Relat.	Ind./Hyp.-Ded.
The issue of Reality	Realism/Sc. Realism	Scepticism/Log. Positivism

TABLE T9.1

As discussed earlier (section VIII.6.3), the table shows that the way in which contextualism is favoured and what positions are rejected depends on the theme under consideration.

Comparing the findings of this study with previous research, there are two points which warrant some comment. Firstly, there is evidence that there has been a shift in teachers' views away from the traditionally prevailing empirico-inductive position, towards systems which emphasize more the historical and social dimensions of scientific knowledge. This shift however is not uniform, but depends on the theme under question. An extreme relativistic position seems to emerge with regard to the status of scientific knowledge, while insofar as the question of scientific methodology is concerned one can still detect a strong stream of inductivists (see section VIII.6.1).

It should be made clear that, as stated in section VI.4.1, the orientation of previous studies generally tended to be different, in the sense of attempting to investigate the impact which complex systems in their totality have on teachers' thought.

Thus, it may be that the dissection of the relevant philosophical -epistemological issues into constituent themes in the present work is of some significance. For instance to define conceptual areas within which teachers have consistent views from a philosophical perspective can in principle permit one to draw a more satisfactory picture. The term satisfactory is employed here in two senses. This strategy means that there is a better chance of picturing teachers' views as they are, and not as "inconsistent" when viewed only in the frame of a given total position. Furthermore, by facilitating reconstruction of meaningful patterns for a given theme one can study the interaction of other sets of opinions (e.g. curricular) with teachers' views concerning this theme.

Clearly, this is not to say that the drive to reconstruct teachers' philosophical views in a more integrated form is to be dismissed. It is rather that such a task is perhaps more feasible if attention has been paid beforehand to narrower conceptual units.

Admittedly, the sets of views under discussion here are by no means stable and well defined. Furthermore, given the complexity of the issues under consideration, and the fact that though generally recognised by educationists as essential, their application is not self-evident, a degree of simplification is not only inevitable but arguably necessary. The above conclusions should be seen in this light.

B. Curricular views: Integration of the science curriculum.

The questions about the science curriculum were confined to the area of the integration of the science curriculum, and to the meaning of content and process in science.

1. With regard to the issue of whether to teach specialised scientific subjects or one integrated subject, more teachers seem to favour integration. The reasons chosen for such a reform were conceptual and methodological similarities (epistemic considerations) as well as the belief that integration can provide the basis for socially relevant curricula (see section VIII.6.2).

This position of the majority appears to contradict the arguments put forward by Hirst [2] and Phenix [3] concerning the distinct forms of knowledge (e.g. physics-chemistry as opposed to biology), being more in accord with a Kuhnian interpretation of Schwab's thesis (see chapter II), and with sociological considerations.

Regarding previous findings Brown, MacIntyre, Drever and Davis reported that teachers "placed considerable importance on resource constraints. The particular resource problem of a given school influenced the favour with which integration was viewed - evidence of such problems was readily available" [4]. Interestingly, this finding coincides with the view of the minority (who preferred specialisition) in the present study, their argument being based on their belief that differences in content were sufficient to warrant distinct subjects, in addition to considering integration difficult on practical grounds.

2. It seems to be of interest to discuss how teachers understand the terms "content" and "process" in science in the light of their epistemological and philosophical beliefs. Most of the teachers appeared to think that content and process are related, and furthermore see the content mainly as experimental data, whilst to the term "process" the meaning attached is that of techniques of experimentation (see section VIII.6.2).

This seems to suggest that the fact of the detected shift of allegiances away from an empirico-inductive image of science expressed in epistemological terms is not necessarily transferred to practical decisions. Thus, when it comes to concrete educational choices, it becomes clear that old beliefs die hard. Furthermore, at the ontological level, where scientific realism is the favoured system, this emphasis on experimentation resembles Hacking's [5] position, where he argues that "experimental work provides the strongest evidence for scientific realism". This pattern is consistent with the findings of the correlation study. Indeed, the interpretation of the correlation between views about the existence of theoretical and observational entities and the meaning of content and process in science education,resulted in a much more meaningful pattern (see table VIII.78) than the same attempt when the first element was teachers' epistemological views (see section VIII.7.2(13)).

C. Pedagogical views: Across several dichotomies.

The last component refers to general pedagogical principles i.e. assumptions about learning, instruction and classroom activities.

1. The system termed in this thesis "cognitivism" (Piagetian orientation) was teachers' most favoured single choice in terms of

learning assumptions. This choice however, was by no means made by a majority (only 27%). As stated in section VIII.6.2 this could be interpreted as either a genuine phenomenon, or, given the immediate relevance of the assumptions under consideration for teachers, it may also indicate a weakness in the analysis which preceded the construction of the research instrument.

Nevertheless one could discuss this outcome in the light of "a more general dichotomy - oversimplified as it is between two distinctively different conceptions of learning" (Marton, [6]). According to Marton s distinction one could see learning either as "a qualitative change in one's way of understanding some aspect of reality" or to understand learning as "to memorise something, to be able to retell something one has read" [7]. It can be argued that, of the systems distinguished in this study, cognitivism and constructivism are more akin to the first of the above versions while behaviourism fits more with the second. In this light, according to the evidence collected here, teachers appear to understand learning primarily as a qualitative change in one s way of understanding.

This however collapses the two conceptions of learning above (i.e. cognitivism and constructivism), which differ rather fundamentally in terms of their philosophical-epistemological foundations.

The philosophical starting points of the Piagetian school of thought as Piaget himself argues them, can be summarised as taking a position which is:

-naturalist but not positivist;

-one which stresses the activity of the subject without being idealist;

-one that bases itself on the object which "it considers as a limit (therefore existing independently of us but never completely reached)" [8].

By contrast, the philosophical underpinnings of constructivism, as reflected for instance in the paradigm of investigating childrens' ideas in science education, are arguably a combination of methodological inductivism (scientific methodology) with some relativistic influence (status of scientific knowledge) which in the view taken in this thesis is on the one hand, difficult to interpret in a realistic framework and on the other, consistent with idealistic ontological tendencies (section II.2.1). One might note that this set of positions, taken by a number of science educationalists, is in fact rather close to the broad picture of teachers' views found in the present study.

If now we see teachers' assumptions about learning in relation to their views about reality, scientific methodology and the status of scientific knowledge, one can speculate that the sources of influence are divided (i.e. scientific realism was teachers' choice at the ontological level, while scientific knowledge appears not to be treated as special). It may be therefore that the division between cognitivism and constructivism reflects after all some genuine situation.

2. The evidence suggests somehow evenly distributed views as far as teachers' assumptions about instruction are concerned. As stated however in section VIII.6.2 (table T8.30), teachers and P.G.C.E. students appear to favour an approach which consists of:

-a balanced orientation in terms of the teaching model to be adopted (use of clearly defined objectives but in such as way as to leave the teacher the flexibility to intervene according to the needs of the moment);

-active participation as the main motivational force and

-occasional use of reinforcement.

There is not the same unanimity about the pacing of knowledge. Thus, P.G.C.E. students tend to prefer the presentation of the whole idea initially while teachers' stance seems to be the presentation of knowledge in small steps. Interestingly, the same differentiation of opinions emerges if one looks at the results taking into account the subjects of specialisation. Physicists lean towards the first of the above positions while chemists and biologists tend to take the second one.

Seeing the results across this dichotomy (i.e. presentation of the whole idea or proceeding gradually in small steps) the majority (75.3%) among the teachers and students who took a stance (who amount to 72.6% of the whole sample) tend to prefer the presentation of knowledge in small steps, while only 24.7% advocate the initial presentation of the whole idea. It may be noted, then, that there is considerable support for a teaching approach which is consistent with a behaviourist philosophy.

3. The last theme of the pedagogical component concerns assumptions about classroom activities. In this theme teachers tend to choose clear explanations to which pupils should attend, and carefully guided "discovery" (as opposed to investigations by pupils of problems of their own choice), as being the essential activities which should take place during science lessons, in addition to considering knowledge of the subject and of effective teaching techniques as vital features of a good science teacher. In this, teachers do not seem so willing to accept that to understand pupils' thinking well, or to respect pupils' own decisions about their learning, are of primary importance. These views are consistent with their tendency not to accept constructivism, which emphasises these aspects of teaching.

Bruner has distinguished two kinds of teaching: "that which takes place in the expository mode and that in the hypothetical mode. In the former the decisions concerning the mode the pace and style of exposition are principally determined by the teacher as expositor; the student is the listener" [9] whereas "in the hypothetical mode the teacher and the student are in a more co-operative position with respect to what in linguistics would be called 'speakers decisions'. The student is not a bench-bound listener but is taking a part in the formulation and at times may play the principal role in it" [10]. Looking at the results in terms of this distinction, it could be argued that the findings indicate that teachers appear to lean more towards the expository (vis-a-vis the hypothetical) mode.

Given that the assumptions about classroom activities are the statements which most concern classroom interactions, the results regarding this theme may helpfully be seen in the light of studies which investigate directly (e.g. by observation) teachers practice in classroom. It seems that teachers' preferences when asked directly, tend to coincide with their actual practice, since as Galton M. and Eggleston J. [11], who apply STOS, found: "the categories, teacher makes statements and teacher directs pupils were the most frequently observed indicating that pupil autonomy with respect to control of the learning activity was in little evidence" and "the pupil initiated and maintained activity categories were much less than teacher-directed behaviour". Hacker R. J. [12], using the same instrument, reports similar conclusions for Canadian teachers.

D. Correlations: Towards exploring "educational theory".

One of the initial aims of the study was to investigate links between the philosophical, curricular and pedagogical components as well as to find out the extent to which individuals follow consistently the same system within the philosophical-epistemological component. For this reason a study of correlations was carried out.

1. As shown in table T8.38, which is also illustrated by figure F8.4 (see section VIII.7), it is evident that teachers' views concerning the various themes are correlated significantly within and across components. Not surprisingly the curricular and pedagogical components are "integrated", in the sense that all the themes belonging to each are correlated with the others belonging to the same component. In the philosophical component there is also correlation amongst its themes, with the exception of the theme referring to ontological issues which has no correlation with the other philosophical themes. Thus, it appears that it is not ontology which sustains teachers' epistemological beliefs, whatever philosophers may lead one to expect or hope. However, teachers' ontological views are of considerable educational significance, since there is evidence of strong correlation between them and their views regarding the science curriculum.

2. A detailed study of the correlations between the themes of the epistemological part of the philosophical component (i.e. the themes of scientific methodology, criteria of demarcation, patterns of scientific change and the status of knowledge) corroborates the findings of the analysis of teachers' views about these themes (table T9.1). According to both analyses a gradual shift, away from philosophical systems in which science is conceived as a single rational entity, towards more relativistic positions, takes place as one looks successively at teachers' views moving from the theme of scientific methodology to criteria of demarcation and patterns of scientific change to end up with teachers' views concerning the status of scientific knowledge.

Within this general framework one can discern two groups of teachers (in addition to a third group of people who appear to be consistently "eclectic"). The first group seems to subscribe to inductivism (for scientific methodology), contextualism B (for criteria of demarcation), contextualism B (for patterns of scientific change), contextualism A/relativism (status of scientific knowledge). The second group appears to follow contextualism B/A (scientific methodology), to advocate demarcation of scientific theories based on rational criteria, to subscribe to contextualism A (patterns of scientific change), and while accepting some special status for the scientific knowledge, are undecided as to the basis of such a claim. The only exception then, regarding the above mentioned general pattern about how teachers views change as one moves from one theme to another, is the views of the second group concerning the status of scientific knowledge (see table T8.75 and figure F8.5). On the present evidence, this grouping can only be tentative. It could be tested by a multivariate analysis with an instrument better adapted to the purpose.

It thus appears that the way in which teachers views about the epistemological part of the philosophical component are associated, seems to entail some kind of internal tension, if seen from a purely philosophical standpoint. It is not self-evident however, that teachers ought to have an absolutely coherent philosophical position. Furthermore, it has already been pointed out that teachers' philosophical beliefs tend to a large extent to resemble the epistemological position which the recently growing body of research in science education concerning children s "pre-scientific" ideas seems to imply. This of course, does not cancel questions of the origins of such a formulation of beliefs, or of why teachers think (if they do think so) that this general philosophical orientation is conducive either to science teaching or to the image of science it projects to pupils.

Another point related to teachers' philosophical-epistemological beliefs concerns the impact which the diversity of the philosophical systems held by teachers exerts on pupils. Again, this can seen either from the standpoint of whether or not it enhances pupils understanding of science, or in terms of attitudes such a proliferation helps to create. To elaborate, one can further ask:

a. is this proliferation of views healthy, in that by exposing (even implicitly) pupils to different philosophies of science might one expect pupils to understand science better and to acquire a positive image of science? Or, is the fragmentation detrimental (especially when not explicit) in the sense of frustrating pupils?

5. Furthermore, how does it bear upon attempts to achieve educational equality? If one believes that a prerequisite of such an attempt is to create equality in terms of conditions, should one extend the notion of conditions so as to include this set of beliefs? Is it justified? Is it feasible? If not, is there any course of action to mitigate these effects?

3. For the curricular component the analysis could be seen as leading to the identification of two groups with a substantial following (see table T8.76). Both of these groups tend to favour the introduction of integrated science curricula as well as to support the view that scientifc content and process should be treated as conceptually related. What differentiates them is the meaning attached to the terms "content" and "process" in science education, and the arguments which the teachers seem to prefer for integration. Thus, the first group appears to advocate the integration of scientific curricula (as opposed to specialised subjects) mainly for practical reasons. Furthermore, they interpret scientific content as consisting of experimental and observational data, and scientific process as connected with methodological considerations. For the second group the justification of the introduction of integrated courses in science lies in epistemic considerations (similarities in content and methods), as well as in the belief that integration facilitates the attempt to make scientific curricula socially relevant. The term "content" is again taken to mean observational or experimental facts, while process is understood as generally dealing with experimentation techniques (see table T8.76). A third minority group will be discussed later.

4. In as far as the pedagogical component is concerned two groups of teachers can be discerned. Teachers of the first group seem to subscribe to a Piagetian conception of learning ("cognitivism"); to envisage instruction (see section II.2.2) in terms of (a) a balanced orientation which makes use of clearly defined objectives, but allows teachers to intervene if the circumstances call for it, (b) presentation of knowledge in small steps, (c) reinforcement as an integral part of teaching and (d) emotional involvement as the principal motivational force. Furthermore, they prefer the expository mode of teaching (teacher being in control of the knowledge

transactions in the classroom), while on the other hand, they accept that understanding of pupils' thinking and respect for pupils' own decisions about their learning should be included in the traits of a successful teacher. The second group of teachers tend to favour behaviourism (see section II.2.1), to stress the value of active discussions between teachers and pupils and similarly of investigations by pupils of problems of their own choice (presumably a more inquiry oriented approach to teaching), and simultaneously to share with the first group concerns regarding the attention that should be paid to pupils thinking and self-perception of needs (see table T8.77).

5. The final step (which might be seen in a way as reconstructing the body of "educational theory" of teachers), is to discuss the correlations across components, i.e. the correlations between the themes of:

(a) philosophical - curricular components,

(b) philosophical - pedagogical components and

(c) curricular - pedagogical components.

6. The evidence suggests that in terms of the first of the above pairs of components, the teachers' ontological position is the element which is associated with their curricular views. Specifically, as shown by tables T8.78 and T8.79 teachers who tend to lean towards scientific realism, also tend to take the minority view (the first of the discerned groups in the curricular component - see section VIII.7.1(7), table T8.76) that the teaching of specialised subjects is preferable because of differences in the content as well as for practical reasons. Furthermore, they hold that content and process in science are distinct conceptually, content having the meaning of experimental and observational data, while for process experimentation techniques are central. It should be noted that:

(a) as already mentioned, this meaning of process tends to be consistent with Hacking's interpretation of scientific realism,

(b) this view of content and process, which suggests some empirico-inductive leanings, is in accordance with the outcome of the correlational analysis, which indeed indicates that inductivists tend to view content and process in this way (see section VIII.7.2.(11)).

As shown in table T8.26, the other main stream regarding the ontological question is teachers who appear to espouse idealism. For these teachers content and process are conceptually related and the meaning attached to these terms are the same as in the above group (see table T8.78). However, unlike the realists, they tend to favour the introduction of "integrated" science (the second of the discerned groups in the curricular component - see table T8.76).

7. In so far as the correlation between the themes of the philosophical and pedagogical components is concerned, as argued in section VIII.7.2(16) (see tables T8.80 and T8.81), a pattern can be established: there is a parallel shift of teachers' views at the levels both of epistemological and of pedagogical assumptions. Thus, teachers who conceive learning in behavioural terms (skills, ability to demonstrate knowledge) and follow more traditional approaches in terms of control of classroom activities (e.g. expository subject-centred approach), tend also to have more "rationality"-bound image of science. Teachers on the other hand who appear to emphasise the individual construction aspects of learning ("constructivists") see science in a more relativistic light, while the Piagetian-oriented stream of teachers occupy an in-between position in epistemological terms.

8. Arguably the above discerned patterns have some significance because:

a. they provide the basis for some hypotheses which, if further investigated, can enhance our understanding of the "educational theory" teachers hold.

b. by underlining the association of philosophical considerations with pedagogical assumptions serves as a means to verify an initial hypothesis of this study, that there is a significant interaction between teachers beliefs concerning on the one hand philosophical-epistemological dimensions of scientific knowledge and curricular-pedagogical general principles on the other.

9. Finally, correlations between teachers' curricular and pedagogical assumptions remain to be considered. As shown in table T8.38 there is evidence of correlations between the themes belonging to these two components (with the exception of the pair "integration in science" and "assumptions about learning", which do not correlate significantly). However, the pattern of associations presented in section VIII.7.2(17)

is complex, and not easy to interpret.

10. For an overall conclusion concerning the articulation of the philosophical, curricular and pedagogical components, the patterns detected seem to point towards a hypothesis that there exist two relatively autonomous regions, i.e. epistemological and pedagogical interrelated elements on the one hand and ontological - curricular on the other, which constitute parts of the educational theory teachers hold.

E. Differences between groups of teachers.

1. In this study, the views of the respondents were also analysed in terms of the subject of teachers' specialisation (physics, chemistry, biology), and the distinction between P.G.C.E. students and practising teachers (see sections VIII.6.1 and VIII.6.2). The salient points of the differentiation of the views in terms of these groupings will now be summarised for the themes where there was evidence of such a differentiation.

1.1 Scientific methodology: biology teachers and practising teachers were more than any other group inclined towards inductivism, while physics teachers tended to prefer contextualism B/A.

1.2 Status of scientific knowledge: physics teachers were the only group for which there was evidence for a considerable following of the view that science has a special status, while biology teachers appear to adopt a relativistic view.

1.3 Ontological question: physics and chemistry teachers favoured realism, while the preferences of biologists were evenly split between realism and idealism.

1.4 Integration of scientific subjects: the differentiation of the views here lies not in the preference for the introduction of integrated curricula which teachers of all specialisations seem to favour, but in the reasons chosen for this preference. Thus, physicists tend to choose practical reasons, while for chemistry and biology teachers epistemic considerations (unity in methods as well as in the conceptual framework of scientific subjects) are important.

1.5 Scientific content and process: the majority of teachers see content and process in science as being conceptually related, but chemistry and biology teachers interpret content as observational and experimental data and process as experimentation techniques. Physics teachers constitute an exception to this trend, as this is the only group where one can detect a current which includes scientific laws in the content.

1.6 Assumptions about instruction: a difference between physics teachers on the one hand, and chemistry and biology teachers on the other, is found in that physics teachers appear to prefer the presentation of the whole idea first and not the pacing of knowledge in small steps, as the other two groups tend to support. It is worth noting that P.G.C.E. students follow physics teachers in this preference, while the pattern emerging from the analysis of views of practising teachers seems to resemble that of chemists and biologists.

1.7 Assumptions about classroom activities: the main point regarding this theme is that the only group to advocate to a considerable extent a comprehensive pupil-centred approach (both in terms of control of knowledge transactions and features which a teacher should have) was the P.G.C.E. students.

F. Limitations.

1. There are some specific methodological limitations (besides any more general objections one might have to the methodological solutions), which need to be noted in order to put the above conclusions into perspective:

a. the construction of some categories is based on responses to a relatively small number of statements.

b. strictly speaking, the terms "inductivism", "relativism" etc. mean that people answer the statements designed in a certain way, defined by the initial analysis. Therefore, one needs further work in detail to find out whether they mean what they appear to mean.

c. The above limitations are a consequence of attempting to cover a large number of complex positions within a questionnaire (even a large one).

2. Nevertheless there exist meaningful patterns and correlations amongst the responses to the statements, of which there are a fairly large number. It seems reasonable therefore to hope that the outcome of the attempt to interpret the data and draw conclusions has some meaning.

IX.3 Overview: The main findings and some suggestions for further research.

In this section the main findings of this study and some suggestions for further research emanated from them will be presented.

1. The evidence from this and previous studies suggests that teachers do have identifiable views about the philosophical -epistemological basis of science. This study attempted to explore this set of views. Roughly speaking, it appears that teachers tend to value the procedures embodied in science, usually termed "scientific methods", though contextually situated. Furthermore, they tend to subscribe to a realist position i.e. the existence of various entities is independant of human thoughts and the theoretical/observational entities distinction does not necessarily bear upon the question of their existence.

It is therefore interesting that they consider scientific knowledge - the end product of activities which are closely related to the application of scientific methods - in a more relativistic light, that is to say no different than any other body of knowledge which from a methodological standpoint is presumably less well developed. Thus, one can further study if this is a fair picture of teachers views by presenting, for instance, this outcome and asking teachers whether it depicts accurately their views or not. Furthermore one can focus into the question about the reasons why teachers seem to take one view with regard to scientific methodology and another more relativist view as far as the status of scientific knowledge is concerned.

At a different level the detected shift in teachers views (previous research suggests an adherance to empirico-inductive model of science) can be further studied in terms of different age groups of teachers (given that practising teachers whose views were studied in this thesis were young teachers), subject of specialisation, gender and types of school in which they teach (e.g. grammar - comprehensive).

2. As far as the curricular and pedagogical assumptions are concerned

the data seem to suggest that:

a. the introduction of integrated courses is favoured by teachers.

b. teachers "definitions" of the terms content and process rely on an empirical image of science.

c. teachers pedagogical positions are still rather traditional encompassing teachers' control of knowledge transactions, presentation of knowledge in small steps and emphasising the importance of pupils' abilities to think in abstract terms. Interestingly, PGCE students appear to advocate a comprehensive "child-centred" approach.

These results are "weaker" than the results concerning their philosophical views, at least in the sense that the initial analysis which preceded the construction of the instrument referring to the philosophical component, was better researched. A more in-depth examination then, of the curricular - pedagogical assumptions of teachers in relation to their philosophical views would be useful.

3. The study of correlations suggests that teachers epistemological beliefs tend to be correlated with their basic assumptions about learning, instruction and classroom activities. Furthermore, the way teachers conceive reality appear to be associated with their views about the integration of scientific curricula and the meanings attached to the terms content and process in science. Interestingly the ontology and epistemology are not perceived as being connected.

An interpretation of these results could be that there exist two relatively autonomous regions of the educational theory teachers hold, i.e. epistemological and pedagogical interrelated elements on the one hand and ontological - curricular on the other. Thus, one can study why teachers ontological views do not correlate with their philosophical views, as well as the reasons why teachers seem to think that curricular issues are connected with their position regarding the issue of reality.

4. It has been already suggested that it may be useful to investigate the origin of differentiation of teachers' views in terms of the subject of their specialisation. One can further look at the extent to which the substantive and syntactical structures of every discipline (i.e. physics, chemistry, biology) are perceived differently by

teachers, as well as the effect that such differences (if any) have in shaping teachers' views.

5. The problem of the origin and the factors which may have influenced teachers' views have not been addressed here. However, an indirect inference concerns the congruence of science teachers' views with current science education work (e.g. SSCR).

In this context an interesting question (bearing in mind that correlation does not mean causation [13]) is to investigate their relationships in terms of causation, especially if one holds that action towards change should take place. Carillo-Gamboa [14] in his thesis argues that it is pedagogy which takes precedence and shapes teachers' philosophical views. It would be interesting to find out whether this connection is more direct. On the other hand one may note that teachers receive scientific training (which implicitly carries a certain philosophy of science) prior to any educational studies. For teachers therefore who are committed intellectually to their subject (as opposed to their role as teachers) the interaction between philosophical and pedagogical beliefs may be far more complex.

IX.4 Some personal reflections.

In this final section, I would like to state briefly a personal view about the findings of this research.

The more secure results are those referring to the mapping of teachers' philosophical-epistemological views, and indeed, I regard the conclusions based on them as potentially helpful in making explicit the often implicit assumptions and therefore by using them in training teachers, developing curricula and co-ordinating textbooks and other teaching material useful in enhancing pupils' understanding of science.

However, it is the conclusions from the correlational study which I consider to be more interesting and challenging. Being an optimist, I believe that an attempt to reconstruct from a conceptually wide perspective the educational theory which teachers hold, so as to avoid the otherwise inevitable fragmentation, is both helpful and in principle feasible, although the extensiveness for one thing, not to mention the complexity of the issues involved, clearly make such an enquiry extremely difficult. This, I consider to be one of the origins of the weaknesses which are undoubtedly reflected on the correlational results. Thus, no claim is made that an integrated body of educational theory has been reconstructed. But, it would be a source of personal satisfaction, if this work is judged simply as pointing towards this direction.

BIBLIOGRAPHICAL NOTES.

[1] Dibbs, D. R. (1982).

[2] Hirst, P. H. (1969).

[3] Phenix, P. H. (1964).

[4] Brown, S. A., McIntyre, D. I., Drever, E. and Davis, J. K. (1976), cited in S. A. Brown (1977).

[5] Hacking, I. (1983), p. 262.

[6] Marton, F. (1983), p. 291.

[7] Ibid.

[8] Piaget, J. (1968), translation (1971).

[9] Bruner, J.(1961), cited in D. Barnes (1975), p. 114.

[10] Ibid.

[11] Galton, M. and Eggleston, J. (1979), p. 79.

[12] Hacker, R. G. (1984).

[13] Evans, J. (1979), pp. 17-20.

[14] Carrillo-Gamboa, F. G. (1986).

BIBLIOGRAPHY

Abimbola, I. O. (1983), "The relevance of the 'new' philosophy of science for the science curriculum" (Sch. Sci. and Maths., 83:181-193).

Adelman Clem and Young M. F. D. (1985), "The assumption of educational research: The last twenty years in Gr. Britain" in M. Shipman (ed.) "Educational research: principles, policies and practices" (London and Philadelphia: The Falmer Press).

Aikenhead, G. S. (1973), "The measurement of high school students' knowledge about science and scientists" (Science Education, 57, 4:539-549).

Akeroyd, M. (1983a), "Chemistry and the philosophy of science" (Sch. Sci. Rev., Part I, 64:765-767).

Akeroyd, M. (1983b), "Chemistry and the philosophy of science" (Sch. Sci. Rev., Part II, 65:136-138).

Althusser, L. (1970) "Reading Capital" (London: New Left Books).

Ashby, R. W. (1964), "Logical Positivism", in D.J. O'Connor (ed.) "A critical History of Western Philosophy" (Free Press of Glencoe).

Ayer, A. J. (1956), "The Problem of Knowledge" (Penguin books).

Ayer, A. J. (1976), "The Central Questions of Philosophy" (Penguin books).

Bacon, F. "The new Organon" ed. (1960), (Indianapolis: Bobbs-Merrill).

Barnes, B. (1977), "Interests and the growth of knowledge" (London: RKP).

Barnes, B. (1982), "T. S. Kuhn and Social Science" (The Macmillan Press).

Barnes, B. and Bloor, D. (1983), "Relativism, Rationalism, Sociology of Knowledge" in M. Hollis and S. Lukes (eds) "Rationality and Relativism" (Oxford: Basil Blackwell).

Barnes, D. (1976), "From communication to curriculum" (Penguin Books).

Behnke, F. L. (1968), "Reactions of scientists and science teachers to statement bearing on certain aspects of science and science teaching" (School Science and Mathematics, 61:172-179).

Berdie, D. R. and Anderson, J. F. (1974), "Questionnaires: Design and Use" (The Scarecrow Pr., N.J.).

Berger, P. and Luckmann T. (1984), "The Social Construction of

Reality", (Pelican Books).

Berkeley, G. "The works of George Berkeley" (ed.) by A. A. Luce and T. E. Jessop (1951).

Bernstein, B. (1970), "Education cannot compensate for society" (New Society, 26 Feb. 1970).

Bernstein, B. (1971), "On the classification and framing of educationalknowledge" in M. F. D. Young (ed.) "Knowledge and control" (London: Collier-Macmillan).

Bernstein, B. (1973), "Class, Code and Control: Applied Studies. Towards a Sociology of Language" vol. 2, (London: RKP).

Bileh, V. Y. and Malik, M. H. (1977), "Development and application of a test on understanding the nature of science" (Sci. Educ., 61, 559-571).

Biological Sciences Study Committee (BSSC), (1963), "Process of science test" (NY: The psychological corporation).

Blalock, H. M. (1979), "Social statistics" (McGraw-Hill).

Bliss J. and Ogborn J. (1977), "Students' Reaction to Undergraduate Science" (London: Heinemann Educational Books).

Bliss J. and Ogborn J. (1979), "The analysis of qualitative Data" (Eur. Journ. of Sci. Educ., 1,5:427-440).

Bliss, J. Monk, M. and Ogborn, J. (1983), "Qualitative data analysis for educational research" (Croom Helm).

Bloom, B. S. (1970), "Toward a theory of testing which includes measurement - evaluation - assessment" in M.C. Wittrock and D.E. Wiley "The Evaluation of Instruction: Issues and Problems" (New York: Holt, Rinehart and Winston).

Brand, G. (1979), "The central Texts of Wittgenstein" (Oxford: Basil Blackwell).

Brown, L. M. (1974), "Relationships between progressivism, traditionalism, dogmatism, and philosophical consistency in selected urban secondary and elementary school teachers" (Dissertation Abstracts International, May, Vol. 34, (11-A), 7096-7097).

Brown, S. A. (1977), "A review of the meanings of, and arguments for, integrated science" (Studies in Science Education, 4:1977).

Brown, S. A., McIntyre, D. I., Drever, E. and Davies, J. K. (1967) "Innovations in integrated science in Scottish secondary schools", in "Stirling Educational Monographs" No. 2, (University of Stirling: Department of Education).

Bruner, J. S. (1966), "Towards a theory of instruction" (Harvard University Press).

Bruner, J. S. (1961), "The Act of Discovery" reprinted in J. S. Bruner (1965) "On Knowing: Essays for the Left Hand" (Harvard University Press).

Butzow, J. W. and Linz, L. W. (1973), "A model for determining the objectives of science education" (Science Education, 57 (1):15-18).

Carey, R. L. and Stauss, N. G. (1970), "An analysis of experienced science teachers' understanding of the nature of science" (School Science and Mathematics, Vol.LXX, 5, Whole 619:366-376).

Carnap, R. (1962), "Logical Foundations of Probability" (Chicago: University of Chicago Press, 2nd ed.).

Carrilo-Gamboa, F. G. (1986), "Aquisition of scientific patterns of behaviour" (Unpublished Ph.D. thesis, University of London).

Cawthron, E. R. and Rowell, J. A. (1978), "Epistemology and science education" (Studies in Science Education, 5:31-39).

Chalmers, A. F. (1982), "What is this thing called Science?" (Open University Press, 2nd ed).

Child, D. (1981) "Psychology and the teacher" (3rd edition, London: Holt, Rinehart and Winston).

Cohen, L. and Manion, L. (1985), "Research methods in education", (Croom Helm).

Conant, J. B. (1947), "On understanding science: an historical approach" (Oxford: Oxford University Press).

Connely, F. M. (1969), "Philosophy of science and the science curriculum" (Journal of research in science teaching, 6:108-113).

Connely, F. M. (1971), "Review of : The nature of Science and science teaching" (The school review, 79).

Cooley, W. W. and Klopfer L. (1961), "Test on Understanding Science: Form W.", (Princeton: New Jersey Educational Testing Service).

Crumb, G. H. (1965), "Understanding of Science in high school physics" (Journal of research in Science Teaching, 3:246250).

Dibbs, D. R. (1982), "An investigation into the nature and consequences of teachers' implicit philosophies of science" (Unpublished Ph.D. thesis, University of Aston).

Dolby, R. G. A. (1971), "Sociology of Knowledge in Natural Science" (Sci. Studies, 1, 1:3-21).

Donnely, J. (1979), "The work of Popper and Kuhn on the nature of science" (Sch. Sci. Rev., 60:489-500).

Doran, R. L., Guerin, R. O. and Cavalieri J., (1974), "An analysis of several instruments measuring "Nature of science" objectives" (Science Education, 58, 3:321-329).

Driver, R. and Easley, J. (1978), "Pupils and Paradigms: a Review of Literature Related to concept development in adolescent science students" (Studies in Science Education, 5:61-84).

Driver, R. and Erickson, G. (1983), "Theories-in-action: Some

theoretical and empirical issues in the study of students' conceptual frameworks in science" (Stud. Sci. Rev., 10:37-60).
Durkee, G. P. (1974), "An analysis of the appropriateness and utilization of TOYS with special reference to high ability students studying Physics" (Science Education, 58, 3:343-356).

Eggleston, J. F. (1975), "Studies of science Teaching processes" in G. P. McFadden (ed.) "World Trends in Science Education" (Atlantic Institute of Education: Halifax, Nova Scotia).
Elkana, Y. (1970), "Science, philosophy of science and science teaching" (Educ. Phil. and Theory, 2, 15-35).
Elkana, Y. (ed.) (1975), "The interaction between science and philosophy" (N.J.: Humanities Press).
Entwistle, N. (1984), "Outcomes of learning" in F. Marton and P. Hounsell and N. Entwistle (eds.), "The experience of learning" (Edinburgh: Scottish Academy Press).
Entwistle, N. and Hounsell P. (1979), "Editorial" (Higher Education, N.8:359-363).
Espagnat, B.d' (1983), "In Search of Reality" (Springer-Verlag).
Evans, J. (1979), "Research Design, Block 3A" (Open University Press).
Eysenck, H. J. (1952), "The scientific study of personality" (London:RKP).

Feigl, H. (1970), "The Orthodox View of Theories", in M. Radner and S. Winokur (eds) "Analyses of Theories and Methods of Physics and Psychology" (Minneapolis: University of Minnesota Press).
Fenstermacher, G. D. (1980), "The nature of science and its uses for education: remarks on the philosophical import of Schwab's work" (Curr. Inquiry, 10, 191-197).
Feyerabend, P. K. (1970), "Consolations for the Specialist" in I. Lakatos and A. Musgrave (eds) "Criticism and the Growth of Knowledge" (Cambridge University Press).
Feyerabend, P. K. (1975), "Against method" (London: New Left Books).
Feyerabend, P. K. (1978), "Science in a Free Society" (London: New Left Books).
Finley, F. N. (1983), "Science Processes" (J. Res. Sci. Tchg., 20:47-54).
Firth, J. R. (1957), "Linguistic Papers 1934-51" (OUP: London).
Forge, J. C. (1979), "A role for philosophy of science in the teaching of science" (Journal of Philosophy of Education, 13:109-118).
Fraasen, van B. C. (1980) "The scientific image" (Oxford: Claredon Press).
Fransella, F. and Bannister, D. (1977), "A manual for repertory grid

technique" (Academic Press: London, N.Y., San Francisco).
Freundlich, Y. (1980), "Philosophy of science and the teaching of scientific thinking" (Teach. Coll. Rec., 82:117-123).
Furth, H. G. (1969), "Piaget and Knowledge" (N.J.: Prentice Hall).

Galton, M. and Eggleston, J. (1979), "Some characteristics of effective science teaching" (Eur. J. of Sc. Ed., 1, 1:75-85).
Gardner, P. L. (1972), "Structure-of-knowledge theory and science education" (Educ. Phil. and Theory, 4, 25-46).
Gardner, P. L. (1975), "Science and the structure of knowledge" in P. L. Gardner (ed.) "The structure of science education" (Hawthorn, Longman, 1-40).
Gauld, C. F. and Hukins A. A. (1980), "Scientific Attitudes: A Review" (Studies in Science Education, 7:129-161).
Geymonat, L. (1973) "Neopositivistic Methodology and Dialectical Materialism" (Science and Society" Summer, 1973: 178-194).
Guilford, J. P. and Fruchter, B. (1981), "Fundamental statistics in psychology and education" (McGrow-Hill).

Hacker, R. G. (1984), "A typology of approaches to science teaching in schools" (Eur. J. Sci. Educ., 6, 2:153-167).
Hacking, I. (1979), "Imre Lakatos's Philosophy of Science" (British Journal for the Philosophy of Science, 30).
Hacking, I. (1981) "Lakatos s Philosophy of Science", in I. Hacking (ed.) "Scientific Revolutions" (Oxford University Press).
Hacking, I. (1982), "Language, Truth and Reason", in M. Hollis and S. Lukes (eds) "Rationality and Relativism" (Basil Blackwell, Oxford).
Hacking, I. (1983), "Representing and Intervening" (Cambridge University Press).
Halliday, M. A. K. (1978), "Language as a Social Semiotic" (Arnold).
Hamilton, N. I. (1974), "A critique of some pedagogical assunptions of Nuffield physics" (Unpublished M.Ed. dissertation, Chelsea Coll., Univ. of London).
Hamilton D. and Delamont S. (1974), "Educational Research in Britain" (Research in Education, 11:1-15).
Hammersley, M. and Atkinson, P. (1983), "Ethnography. Principles in Practice" (London and New York: Tavistock Publications).
Harre, R. (1972), "The Philosophies of Science" (Oxford University Press).
Hart, K., Booth, L., and Turner, A. D. (1982), "Liaison" (Mathematics in schools, Sept. 1982).
Havelock, R. G. (ed.), (1973), "Planning for Innovation through Dissemination and Utilization of Knowledge" (4th printing , Ann

Arbor, Michigan: Center for Research on Utilization of Scientific Knowledge).

Heath, T. (1980), "Observation, perception and education" (Europ. J. Sci. Educ., 2:155-160).

Hegel, G. W. F. "The Phenomenology of mind" trans. by J. B. Baillie (1966), (London: George Allen and Unwin).

Hegel, G. W. F. "The science of Logic" trans. by W. H. Johnston and L. G. Struthers (1966), (London: George Allen and Unwin).

Herron, M. D. (1969), "Nature of science: Panacea or Pandora s Box" (Journal of research in science teaching, 6:107-107).

Herschel, J. F. W. (1830), "A Preliminary Discourse on the Study of Natural Philosophy" (London: Longman, Rees, Orme, Brown & Green and John Taylor).

Hirst, P. H. (1965), "Liberal education and the nature of knowledge" in R. D. Archambault (ed.) "Philosophical Analysis and Education" (Routledge and Kegan Paul, London).

Hirst, P. H. (1974), "Knowledge and the curriculum" (London: RKP).

Hirst, P. H. and Peters, R. S. (1970), "The logic of education" (London: RKP).

Hodson, D. (1982a), "Science - the pursuit of truth?" (Part I, Sch. Sci. Rev., 63, 643-652).

Hodson, D. (1982b), "Science - the pursuit of truth?" (Part II, Sch. Sci. Rev., 64, 23-30).

Hodson, D. (1985), "Philosophy of Science, Science and Science Education" (Studies in Science Education, 12:25-57).

Hollis, M. and Lukes, S. (1983) "Introduction" in M. Hollis and S. Lukes (eds) "Rationality and Relativism" (Basil Blackwell, Oxford).

Hull, C. H., Niew, N. H. (eds) (1981), "SPSS UPDATE 7-9: New procedures and facilities for Releases 7-9" (McGraw-Hill).

Hume, D. "Enquiry Concerning Human Understanding" ed. by L. A. Selby-Bigge (1927), (Oxford).

Hume, D. "A Treatise of Human Nature" ed. by L. A. Selby-Bigge (1965), (Oxford: Clarenton Press).

Ivany, J. W. G. (1969), " Philosophy of science: Implication for curriculum. A reaction" (Journal of Research in Science Teaching, 6:114-115).

Jones, D. M. (1974), "The nature of science and science teaching" (Unpublished M.Ed. dissertation, Chelsea Coll., Univ. of London).

Jones, V. G. (1981), "A study of certain aspects of curriculum innovation in the physical sciences in the light of Popper-Kuhn debate" (unpublished M.Ed. dissertation, King's College, Univ. of

London).

Jungwirth, E. (1970), "An evaluation of the attained development of the intellectual skills needed for "Understnding of the nature of science Enquiry", by B.S.C.S pupils in Israel"(Journal of Research in Science Teaching, 7:141-151).

Kimball, M. E. (1968), "Understanding the nature of science: A comparison of scientists and science teachers" (Journal of Research in Science Teaching, 5:110-120).

Knape, G. and Rosewell P. T. (1980), "The philosophical discerning classroom teacher" (Educational Studies, 11, 1:37-47).

Korth, W. W. (1969), "Understanding the social aspects of science: ERC papers in science Education" (Educ. Res. Counc. of America, Cleveland, Ohaio, 1).

Krige, J. (1980), "Science, Revolution and Discontinuity" (Brighton, Sussex: Harvester).

Kuhn, T.S. (1970), "The Structure of Scientific Revolutions", (Chicago University Press, 2nd ed.).

Kuhn. T.S. (1970), "Logic of discovery or Psychology of Research?", in I. Lakatos and A. Musgrave (eds) "Criticism and the Growth of Knowledge" (Cambridge University Press).

Kuhn, T.S. (1977), "The Essential Tension" (Chicago University Press).

Labaw, P. J. (1980), "Advanced questionnaire design" (Cambridge, Mass.: Abt Books, Reprint).

Lacey, H. (1978), "Skinner on the prediction and control behaviour" (Theory and decision, 4).

Lakatos, I. (1970), "Falsification and the Methodology of Scientific Research Programmes", in I. Lakatos and A. Musgrave (eds) "Criticism and the Growth of Knowledge" (Cambridge University Press).

Lakatos, I. (1971), "History of Science and its Rational reconstruction" in "Boston Studies in the Philosophy of science" vol. 8 (Dordrecht: D. Reidel).

Lakatos, I. (1978a), "The Methodology of Scientific Research Programmes" ed. by J. Worrall and G. Currie (Cambridge University Press).

Lakatos, I. (1978b), "Mathematics, Science and Epistemology" ed. J. Worrall and G. Currie (Cambridge University Press).

Laudan, L. (1981), "A problem solving approach to scientific progress" in I. Hacking (ed.) "Scientific Revolutions" (Oxford University

Press).
Laura, R. S. (1981), "The philosophical foundations of science education" (Educ. Phil. and Theory, 13:1-13).
Lind, G. (1980), "Models in physics: some pedagogical reflections based on the history of science" (Europ. J. Sci. Educ., 2:15-23).
Locke, J. "An Essay Concerning Human Understanding", ed. by J. W. Yolton (1961), vols I and II, (London: J. M. Dent).
Losee, J. (1980), "A Historical Introduction to the Philosophy of Science" (Oxford University Press, 2nd ed).
Lucas, A. M. (1975), "Hidden assumptions in measures of "knowledge about science and scientists"" (Science Education, 59, 4:481-485).

Mach, E. "History and the roots of the Principle of the Conservation of Energy" tran. by P. E. B. Jourdain (1911), (Chicago: Open Court).
McIntyre, D. I. (1980), "Systematic Observation of classroom activities" (Educational Analysis, vol.2, N.2:2-30).
Mackay, L. D. (1971), "Development of understanding about the nature of science" (Journal of Research in Science Teaching, 8, 1:57-66).
McMullin, E. (1984) "A case for scientific realism" in J. Leplin (ed.) "Scientific Realism" (University of California Press).
McMurrin, S. M. (1963), "Philosophy, Science and Education" in B. Baumrin (ed) "Philosophy of science: The Delaware Seminar, Vol.2 (Interscience Publishers, N.Y., London, Sidney).
Margetson, D. (1982), "Science education and philosophy of science", (Res. in Sci. Educ., 11:1-7).
Margolis, J. (1984), "Philosophy of Psychology" (N.J.: Prentice-Hall).
Marton, F. (1983), "Beyond individual differences" (Educational Psychology, Vol.3, Nos 3 & 4).
Masterman, M. (1970), "The nature of a Paradigm", in I. Lakatos and A. Musgrave (ed) "Criticism and the Growth of Knowledge" (Cambridge University Press).
Mitias, R. G. E. (1970), "Concepts of science and scientists among college students" (Journal of Research in Science Teaching, 7:135-140).
Moore, R. W. and Sutman F. X. (1970), "The development, field test and validation of an inventory of scientific attitudes" (Journal of Research in Science Teaching, 7:85-94).
Morrison A. and McIntyre D. (1973), "Teachers and Teaching" (Penguin Books).
Munby, H. (1975), "An evaluation of instruments which measure attitudes to science" in G. P. McFadden (ed) "World Trends in Science Education" (Atlantic Institute of Education: Halifax, Nova Scotia).
Munby, H. (1983), "Thirty studies involving the scientific attitude

inventory: What confidence can we have in this instrument?" (Journal of Research in Science Teaching, 20, 2:141-142).

Nadeau, R. and Desautels, J. (1984) "Epistemology and the teaching of Science" (Ottawa: Science Council of Canada).

Nagel, E. (1969), "Philosophy of science and educational theory" (Stud. Phil. and Educ., 7:5-27).

Newton-Smith, W. H. (1981), "The Rationality of Science" (London: RKP).

Niew, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., Bent, D. H. (1975), "Statistical Package for the Social Sciences" (McGraw-Hill, 2nd edition).

Nock, D. A. and Nelson, R. W. (1982), "Science, ideology and 'reading, writing and riches'" (J. Educ. Thought, 16:73-88).

Noll, V. H. (1935), "Measuring scientific attitude" (Journal of abnormal and social psychology, 30, July-Sept.:154-155).

Ogborn, J. (1980), "Some uses of Networks of Options for Describing Complicated Qualitative Data" in W. F. Archenhold (ed.) "Cognitive Development Research in Science and Mathematics" (University of Leeds).

Ogborn, J. (1985), "Voices of Science" (London: ULIE, inaug. lecture).

Ogborn, J. (1985), "A view of 'Understanding'" (Eur. J. Sci. Educ., 7, 2:141-150).

Ogunniyi, M. B. and Pella, M. O. (1980), "Conceptualizations of scientific concepts, laws and theories held by Kwara State, Nigeria secondary school science teachers" (Science Education, 64, 5:591-599).

Ogunniyi, M. B. (1982), "An analysis of prospective science teachers understanding of the nature of science" (Journal of Research in Science Teaching, 19, 1:25-32).

O'Hear, A. (1985),"What Philosophy Is: An Introduction to Contemporary Philosophy" (Pelican Books).

Oliver, W. D. (1970), "A Sober Look at Solipsism" in N. Rescher (ed.) "Studies in the theory of knowledge" (Oxford: Basil Blackwell).

Oppenheim, A. N. (1972), "Questionnaire design and attitude measurement" (N.Y.: Basic Books).

Orsini-Romano, C. I. (1978), "Progressive-traditional beliefs and personal orientations of pre-service, in-service and re-entry teachers" (Dissertation Abstracts International, Sep., Vol. 39 (3-A), 1239).

Ozga, J. T. and Lawn, M. A. (1981), "Teachers, Professionalism and Class" (Falmer Press).

Papanoutsos, E. P. (1968), "The foundations of Knowledge" edited by J.

P. Anton (State Univ. Press).

Phenix, P. H. (1962), "The disciplines as curriculum content" in A. H. Passow (ed.) "Curriculum Crossroads" (N.Y: Teachers' College Press).

Phenix, F. H. (1964), "Realms of meaning" (N.Y: McGrow-Hill).

Phillips, D. C. (1974), "Perspectives on structure of knowledge and the curriculum" in P. W. Musgrave, (ed.) "Contemporary studies in the curriculum" (Sydney: Angus and Robertson).

Piaget, J. (1968), "The Structuralism" (London: RKP, transl. 1971).

Piaget, J. (1972), "Psychology and Epistemology" (Penguin).

Pine, G. J. and Boy, A. V. (1975), "Teaching: Theory as a guide to practical behaviour" (High School Journal , 59, 3:122-129).

Popham, W. J. (1969), "Objectives and instruction" in W.J. Popham, E.W. Eisner, H.J. Sullivan and L.L. Tyler "Instructional Objectives" in "American Educational Research Association Monograph Series on Curriculum Evaluation" No.3 (Chicago: Rand McNally).

Pope, M. and Gilbert, J. (1983), "Personal experience and the construction of knowledge in science" (Science Education, Vol. 67, 2:193-203).

Popper, K. R. (1963), "Conjectures and Refutations" (London: RKP).

Popper, K. R. (1970), "Normal Science and its Dangers", in I. Lakatos and A. Musgrave (ed) "Criticism and the Growth of Knowledge" (Cambridge University Press).

Popper, K. R. (1977), "The open society and its enemies" (London: RKP, 12th impr).

Popper, K. R. (1979), "Objective Knowledge" (Oxford University Press).

Popper, K. R. (1983) "Realism and the aim of Science" (Hutchinson).

Price, K. (1973), "Of the impact of theory of knowledge on thought about education", in R. M. V. Travers (ed.) "Second handbook of research on teaching" (Chicago: Rand McNally).

Putnam, H. (1981), "The "Corroboration" of Theories" in I. Hacking (ed.) "Scientific Revolutions" (Oxford University Press).

Putnam, H. (1982), "Reason, Truth and History" (Cambridge).

Putman, H. (1984) "What is realism" in J. Leplin (ed.) "Scientific Realism" (University of California Press).

Quine, W. V. (1960), "Word and Object" (Wiley, N.Y.).

Ramsden, P. (1984), "The context of learning" in F. Marton and P. Hounsell and N. Entwistle (eds.), "The experience of learning" (Edinburgh: Scottish Academy Press).

Richardson, M. and Boyle, C. (1979), "What is science?" (Hatfield, ASE study series, No.15).

Roberts, D. A. and Russel, T. L. (1975), "An alternative approach to science education research: Drawing from philosophical analysis to examine practice" (Curriculum Theory Network, 5, 2:107-125).

Robinson, J. T. (1969a), "Philosophy of science :Implications for teachers education" (Journal of research in science teaching, 6:99-104).

Robinson, J. T. (1969b), "Philosophical and historical bases of science teaching" (Review of Educational Research, 39:459-471).

Robinson, M. C. (1984), "Issues in the philosophy and sociology of science in science curriculum design" (Unpublished M.Ed. dissertation, Univ. of Manchester).

Rogers, P. J. (1982), "Epistemology and history in science teaching" (European Journal of Science Education, 4,1:1-10).

Rosen, E. (1959), "Three Copernican Treatises" (New York: Dover).

Rowell, J. A. and Cawthron, E. R. (1982), "Images of sciences: an empirical study" (Eur. J. Sci. Educ., 4, 1:79-94).

Ruben, D.-H. (1979), "Marxism and Materialism: A study in Marxist theory of Knowledge" (The Harvester Press, Sussex).

Russel, B. (1946), "A History of Western Philosophy" (G. Allen and Unwin).

Russel, B. (1973), "The Problems of Philosophy" (Oxford University Press).

Saussure, F. de, (1916), "Course in general linguistics"; Ed. by Bally C., Sechehaye A. and Riedlinger A.; trans. by Baskin W. (1966), (New York: MacGrow-Hill).

Scheffler, I. (1973), "Philosophies-of and the curriculum", in Doyle, J.F.(ed.) "Educational judgements" (London: RKP).

Schmidt, D. J. (1968), "Test on Understanding science: A comparison among several groups" (Journal of Research in Science Teaching, 5, 2:365-366).

Schools' Council (undated) "Integrated science project" (London: SCISP).

Schwab, J. J. (1964), "The structure of the natural sciences" in A.W. Ford and L. Pugno (eds) "The structure of knowledge and the curriculum" (Chicago: Rand McNally, 31-49).

Schwirian, P. M. (1968), "On measuring attitudes toward science" (Science Education, 52, 2:172-179).

Shapere, D. (1964), "The Structure of Scientific Revolutions" (The Phil. Rev. 73).

Scientific Literacy Center (1967), "Wisconsin Inventory of science processes" (The Reagents of the University of Wisconsin, Madison, Wisconsin).

Scottish Education Dept. (1969), "Curriculum paper 7: science for

general education" (Edinburgh: HMSO).
Selkirk, K. (1982), "Links between mathematics and other subjects" in M. Cornelius, (ed.), "Teaching Mathematics" (Croom-Hill).
Skinner, B. F. (1953) "Science and human behavior" (N.Y.: Macmillan).
Smart, J. J. C. (1963) "Philosophy and Scientific Realism" (London: RKP).
Smart, J. J. C. (1968) "Between science and Philosophy" (N.Y.: Random House).
Smolicz, J. J. and Nunan E. E. (1975), "The philosophical and sociological foundations of Science education : The demythologizing of school science" (Studies in Science Education, 2:101-143).
Solomon, J. (1983), "Research into children's prior notions: A survey and a new model" (Unpubl. Ph.D. Thesis, Chelsea Coll., Univ. of London).
Steiner, H. G. (1980), "School curricula and the development of science and mathematics" (Int. J. Math. Educ. Sci. Technol., 11, 1:97-106).
Stenhouse, L. (1975), "An introduction to curriculum research and development" (London: Heinemann).
Stevens, P. (1978), "On the Nuffield philosophy of science" (J. Phil. Educ., 12:99-111).
Stice, G. (1958), "Facts about science test" (Educational testing service, Princeton, N. J.).
Summers, M. K. (1982), "Philosophy of science in the science teacher education curriculum" (Eur. J. Sci. Educ., 4,1:19-27).
Swan, M. (1966), "Science achievements as it relates to science curricula and programs at the sixth grade level in Montana public schools" (Journal of research in science teaching, 4:117-123).
Swartz, R. (1982), "Alternative learning strategies as part of the educational process" (Sci. Educ., 66:269-279).

Taba, H. (1962), "Curriculum Development: Theory and Practice" (New York: Harcourt Brace and World).
Tamir, P. (1972), "Understanding the process of science by students exposed to different science curricula in Israel" (Journal of research in science teaching, 9, 3:239-245).
Tarski, A. (1956), "Logic, Semantics, and Metamathematics" (Oxford University Press).
Tarski, A. (1969), "Truth and Proof" (Scientific American, 220, No. 6).
Tawney, D. A. (1974), "The nature of science and scientific inquiry" in C. R. Sutton and J. T. Haysom, (eds), "The art of the science teacher" (London, McGraw Hill, 19-29).
Tischer, R. P., Power, C. N. and Endean, L. (1972), "Fundamental issues in science education" (Sydney: John Wiley).
Trent, J. (1965), "The attainment of the concept 'Understanding

science", using contrasting Physics courses" (Journal of Research in Science Teaching, 3:224-229).

Turnbull, R. G. (1983) "Episteme and Doxa: Some Reflections on Eleatic and Heraclitean Themes in Plato" in J. P. Anton and A. Preus (eds) "Essays in Ancient Greek Philosophy".

Wagner, P. A. (1983), "The nature of paradigmatic shifts and the goals of science education" (Sci. Educ., 67:605-613).

Wann, T. W. (ed.) (1964), "Behaviorism and phenomenology" (Chigago University Press).

Welch, W. W. (1975), "Evaluation and decision-making in integrated science", in UNESCO "Evaluation of integrated science" (Oxford).

Welch, W. W. and Pella, M. O. (1968), "The development of an instrument for inventorying knowledge of the process of science" (Journal of research in science teaching, 5:64-68).

Westwood, R. D. (1977), "A discussion of the philosophies of science of Karl Popper and Thomas Kuhn and of their educational implications" (Unpublished M.Ed. dissertation, Chelsea College, Univ. of London).

Wetherick, N. E. (1979), "The foundations of psychology" in N. Bolton (ed.) "Philosophical problems in psychology", (Methuen).

Whitaker, M. A. B. (1980), "Kuhn's paradigm and example-based teaching of Newtonian Mechanics" (Eur. J. Sci. Educ., 2:145-153).

Whitfield, R. C. (1971), "Disciplines of the curriculum" (McGraw-Hill).

Wilson, J. M. (1977), "Practical work in physics in Scottish schools" (Sch. Sci. Rev., 58:783-789).

Wilson, J. and Cowell, B. (1982), "Methods of subject teaching: a challenge to current thinking" (Westminster Studies in Education, 5:37-41).

Wittgenstein, L. (1922) "Tractatus Logico-Philosophicus" transl. by Pears and McGuiness (1961).

Wittgenstein, L. (1953), "Philosophical Investigations" transl. by G. E. M. Anscombe (New York).

Wright, P. F. (1982), "Epistemological issues in the design of science curricula" (Unpublished MEd dissertation, Univ. of Manchester).

Young, M. F. D. (1973), "An approach to the study of curricula as socially organized knowledge" in M. F. D. Young (ed.) "Knowledge and Control" (Collier-Macmillan, London).

Ziman, J. (1968), "Public Knowledge" (Cambridge University Press).

Zupp, R. R. (1974), "A study of the effect of two teacher training programs on student teachers' change of attitude, philosophy, and perception of teaching practices" (Dissertation Abstracts International, Jan., Vol. 34 (7-A), 4073).

APPENDIX 1

QUESTIONNAIRE

This questionnaire attempts to find out what teachers think about:

(a)the nature of science
(b)how science should be taught.
(c)what kind of science should be taught.

There are not "correct" answers.You may quite validly, from your own point of view, agree or disagree with any of the alternatives in question.
All your responses are absolutely confidential.
Thank you very much for your cooperation.

A. PRELIMINARY SECTION

Please, tick as appropriate:

```
 1.Male           Female
  ___              ___
 /   \            /   \
 \___/            \___/
```

```
 2.Discipline of specialization:
Physics   Chemistry   Biology   Mathematics   Others(please,specify)
 ___        ___         ___        ___
/   \      /   \       /   \      /   \
\___/      \___/       \___/      \___/
```

3.Have you been taught Philosophy in the course of your previous studies?

```
        Yes           No
        ___          ___
       /   \        /   \
       \___/        \___/
```

```
 4.Nationality.
     British      Others(please specify)
       ___
      /   \
      \___/
```

5.Academic qualification.

```
 ___
:   :B.Ed.        Others(please specify)
:___:
:   :B.Sc.
:___:
:   :M.Sc./M.A./M.Ed.
:___:
:   :M.Phil.
:___:
:   :Ph.D.
:___:
```

6.Years of teaching experince.

B. MAIN SECTION 1

Please (a)tick the alternative of your choice
AND (b)circle S if you feel sure of your choice
or U if you feel unsure of your choice.

1.Science in schools would be best taught

- [ ] a.as separate subjects.
- [ ] b.as one subject.

S---U

2.The content and process of science

- [ ] a.can be distinguished.
- [ ] b.are strongly related.

S---U

3.For the different kinds of scientific enquiry

- [ ] a.there is basically one scientific method.
- [ ] b.there are different ways of being scientific in terms of method.

S---U

4.The scientific method is to

- [ ] a.start from data about a problem, basing hypotheses on the data.
- [ ] b.start by deducing consequences of theories, checking them against the data.

S---U

5.When the consequences of a theory are compared with data, sound conclusions can be drawn

```
 ___
:   :a.if and only if theory and data
:___:agree.

 ___
:   :b.if and only if theory and data
:___:disagree.

          S---U
```

6.In choosing between different scientific methods for a given problem

```
 ___
:   :a.there are standards enabling a
:___:reasonable choice to be made.

 ___
:   :b.there is no rational way of
:___:choosing, other than preference.

          S---U
```

7.When there is a debate about whether a given theory is to be regarded as "scientific"

```
 ___
:   :a.there are rational and
:___:defensible criteria for making the decision.

 ___
:   :b.there are no rational and
:___:defensible criteria for making the decision.

          S---U
```

8.When there are competing theories and scientists want to decide between them

```
 ___
:   :a.there are rational and
:___:defensible ways of doing so.

 ___
:   :b.there are no rational and
:___:defensible ways of doing so.

          S---U
```

C. MAIN SECTION 2

For each alternative below, please give TWO answers:

(a)Do you agree or disagree with the statement?
circle A (for agree) or D (for disagree)
(b)How sure do you feel about your reply (a)?
circle S (for sure) or U (for unsure).

Please, reply to all the alternatives in each question, for example to all alternatives(9a, 9b and 9c) in question 9 below.

9.In your view of science in schools, it is particularly important to teach

9a.the content of science, as opposed to its process.
A---D S---U

9b.the process of science, as opposed to its content.
A---D S---U

9c.both, as a connected entity.
A---D S---U

10.The science to be taught in schools should include

10a.aspects which have historical importance.
A---D S---U

10b.mainly science as it is currently understood.
A---D S---U

11.In your view of science in schools, there should be emphasis on

11a.the distinct nature of different scientific subjects.
A---D S---U

11b.the similarities of different scientific subjects.
A---D S---U

12.In your view, if there are to be arguments for considering science in schools as separate subjects, they would best be based on

12a.differences in content between subjects.
A---D S---U

12b.differences in processes used by subjects.
A---D S---U

12c.reasons of practical convenience.
A---D S---U

12d.the need to maintain high academic standards.
A---D S---U

13. In your view, if there are to be arguments for considering science in schools as one subject, they would best be based on

13a. its basic unity of concepts.
A---D   S---U

13b. its basic unity of methods.
A---D   S---U

13c. reasons of practical convenience.
A---D   S---U

13d. the need to make school science relevant to the pupils.
A---D   S---U

---

14. The giving of praise or blame, or of other forms of "reinforcement"

14a. are an integral part of the process of teaching.
A---D   S---U

14b. may or may not be needed, according to the circumstances.
A---D   S---U

14c. are strictly speaking irrelevant to the process of learning.
A---D   S---U

---

15. It is essential to effective teaching that

15a. it is directed by clearly defined objectives.
A---D   S---U

15b. the teacher can respond or intervene according to the needs of the moment.
A---D   S---U

---

16. The existence of various incompatible scientific methods

16a. is a fruitful source of scientific progress.
A---D   S---U

16b. shows the pointlessness of discussions about scientific method.
A---D   S---U

---

17. In general the choice of the appropriate method to be used for a given problem

17a. is guided by a consensus of the scientific community.
A---D   S---U

17b. itself belongs within the concept of science.
A---D   S---U

17c. is made by individuals, using their own critical standards.
A---D   S---U

18.In general the better of two competing theories

18a.is the one which is nearer to the "truth".
A---D S---U

18b.is the one which gives the more useful results.
A---D S---U

18c.is a matter of consensus amongst scientists arising out of critical scrutiny.
A---D S---U

19.To be sure of approaching nearer to the "truth", one should follow the appropriate scientific method.
A---D S---U

20.The search for general rules for deciding either between competing scientific theories or which one of them deserves to be called scientific

20a.is pointless because when theories change, so do our ideas about how to decide between theories.
A---D S---U

20b.is pointless because science merely persuades us to look at things in a certain way, which is no better than any other.
A---D S---U

20c.is not pointless at all.
A---D S---U

21.As science changes or develops, new knowledge generally

21a.replaces ignorance or lack of knowledge.
A---D S---U

21b.replaces knowledge of another sort.
A---D S---U

22.New scientific knowledge arises mainly through

22a.an accumulation of new experiments and observations.
A---D S---U

22b.a succesion of more general and more complete theories.
A---D S---U

23.New scientific knowledge

23a.either fits within the existing framework,or generates a new framework incompatible with the old one.
A---D   S---U

23b.follows no pattern of growth, being purely the result of what scientists happen to have done.
A---D   S---U

24a.The world of nature exists independently of human thoughts.
A---D   S---U

24b.No objects exist independently of thought about them.
A---D   S---U

24c.There is a no sense in asking whether observable things (like mountains) or unobservable entities (like energy) exist or not.
A---D   S---U

25a.Only observable things e.g. rabbits, radios or chairs. exist.
A---D   S---U

25b.Genes, photons or chemical bonds exist, as do rabbits, radios or chairs.
A---D   S---U

26.The status of scientific knowledge

26a.is different from other kinds of knowledge, having a characteristic value of its own.
A---D   S---U

26b.is not different from that of any other kind of knowledge, all kinds having equal validity.
A---D   S---U

27.Scientific knowledge

27a.has particular characteristics in that it attempts to be an objective account of Nature.
A---D   S---U

27b.has particular characteristics in that it is practically useful.
A---D   S---U

27c.has particular characteristics in that it is a systematic pattern of thought.
A---D   S---U

D. MAIN SECTION 3

Please put the alternatives for each statement in order of priority, e.g.

```
higher    ___________ lower
priority: b : a : c :priority
          :___:___:___:
```

If you feel that some are nearly equal in priority, please do your best to make the distinction. In addition, please circle D(if you think that there is difference) or E(if you feel that the alternatives are nearly equal in priority).

28.The basic goal or aim of teaching should be that pupils

a.develop a rational understanding of the subject.

b.form their own individual view of the subject.

c.acquire the knowledge and skills of the subject.

```
higher    ___________ lower
priority:   :   :   :priority
          :___:___:___:
D---E
```

29.The content of science in schools should include

a.theories and laws.

b.experimental and/or observational data.

c.techniqes of experimentation.

```
higher    ___________ lower
priority:   :   :   :priority
          :___:___:___:
D---E
```

30.In your view of science in schools,the teaching of scientific processes should include

a.scientific methods(how to be scientific).

b.how to handle experimental or observational data.

c.how to devise experiments.

```
higher    ___________ lower
priority:   :   :   :priority
          :___:___:___:
D---E
```

31.To know whether pupils have learned or not, it is important

a.to check what they can or can not be seen to do.

b.to discover whether they have the expected concepts or not.

c.to find out whether they themselves consider that they have learned or not.

```
higher    ___________ lower
priority:   :   :   :priority
        :___:___:___:
D---E
```

32.In presenting knowledge to pupils, it is essential that

a.each new step is small enough to be easy to make.

b.the whole idea being taught is clear at the start.

```
higher    _______ lower
priority:   :   :priority
        :___:___:
D---E
```

33.It is essential to effective learning that account has been taken of

a.pupils' perception of their own needs.

b.pupils' immediate prior knowledge.

c.pupils' ability to think at a sufficient level of abstraction.

```
higher    ___________ lower
priority:   :   :   :priority
        :___:___:___:
D---E
```

34.It is essential in order to motivate pupils

a.that the lesson involves their active participation.

b.that they like or enjoy the subject.

c.that they like the teacher.

d.that they respect the teacher.

e.that they know whether they are doing well or badly.

```
higher    ___________________ lower
priority:   :   :   :   :   :priority
          :___:___:___:___:___:
D---E
```

35.Essential activities in good science lessons are

a.clear explanations to which pupils are attending.

b.investigations by pupils of problems of their own choice.

c.guided "discovery" by pupils of ideas to be learned.

d.active discussion between teacher and pupils.

```
higher    _______________ lower
priority:   :   :   :   :priority
          :___:___:___:___:
D---E
```

36.To become a good teacher, it is essential to

a.know the subject well.

b.understand pupils' thinking well.

c.to be equipped with effective teaching techniques.

d.respect pupils' own decisions about their learning.

```
higher    _______________ lower
priority:   :   :   :   :priority
          :___:___:___:___:
D---E
```

APPENDIX 2

C R O S S T A B U L A T I O N   O F

METHODOLOGY BY DEMARCATION

DEMARCATION

METHODOLOGY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	"truth" 1.00	cont B/pragm 2.00	undecided rat 3.00	cont A/rel 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	2	8	0	3	3	16
	EXP VAL	1.9	4.9	1.2	1.9	6.2	16.8%
	ROW PCT	12.5%	50.0%	.0%	18.8%	18.8%	
	COL PCT	18.2%	27.6%	.0%	27.3%	8.1%	
	TOT PCT	2.1%	8.4%	.0%	3.2%	3.2%	
	RESIDUAL	.1	3.1	-1.2	1.1	-3.2	
	STD RES	.1	1.4	-1.1	.8	-1.3	
	ADJ RES	.1	1.9	-1.2	1.0	-1.8	
2.00 deductivism	COUNT	2	0	0	3	0	5
	EXP VAL	.6	1.5	.4	.6	1.9	5.3%
	ROW PCT	40.0%	.0%	.0%	60.0%	.0%	
	COL PCT	18.2%	.0%	.0%	27.3%	.0%	
	TOT PCT	2.1%	.0%	.0%	3.2%	.0%	
	RESIDUAL	1.4	-1.5	-.4	2.4	-1.9	
	STD RES	1.9	-1.2	-.6	3.2	-1.4	
	ADJ RES	2.0	-1.5	-.6	3.3	-1.8	
3.00 cont B-cont A	COUNT	6	4	5	1	6	22
	EXP VAL	2.5	6.7	1.6	2.5	8.6	23.2%
	ROW PCT	27.3%	18.2%	22.7%	4.5%	27.3%	
	COL PCT	54.5%	13.8%	71.4%	9.1%	16.2%	
	TOT PCT	6.3%	4.2%	5.3%	1.1%	6.3%	
	RESIDUAL	3.5	-2.7	3.4	-1.5	-2.6	
	STD RES	2.2	-1.0	2.7	-1.0	-.9	
	ADJ RES	2.6	-1.4	3.1	-1.2	-1.3	
4.00 undec. rational	COUNT	0	6	0	1	5	12
	EXP VAL	1.4	3.7	.9	1.4	4.7	12.6%
	ROW PCT	.0%	50.0%	.0%	8.3%	41.7%	
	COL PCT	.0%	20.7%	.0%	9.1%	13.5%	
	TOT PCT	.0%	6.3%	.0%	1.1%	5.3%	
	RESIDUAL	-1.4	2.3	-.9	-.4	.3	
	STD RES	-1.2	1.2	-.9	-.3	.2	
	ADJ RES	-1.3	1.6	-1.0	-.4	.2	
10.00 eclectic	COUNT	1	11	2	3	23	40
	EXP VAL	4.6	12.2	2.9	4.6	15.6	42.1%
	ROW PCT	2.5%	27.5%	5.0%	7.5%	57.5%	
	COL PCT	9.1%	37.9%	28.6%	27.3%	62.2%	
	TOT PCT	1.1%	11.6%	2.1%	3.2%	24.2%	
	RESIDUAL	-3.6	-1.2	-.9	-1.6	7.4	
	STD RES	-1.7	-.3	-.6	-.8	1.9	
	ADJ RES	-2.4	-.5	-.8	-1.1	3.2	
COLUMN TOTAL		11	29	7	11	37	95
		11.6%	30.5%	7.4%	11.6%	38.9%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
48.82825	16	0.0000	0.368	20 OF 25 (80.0%)

STATISTIC	VALUE	WITH METHODOLOGY SIGNIFICANCE	WITH DEMARCATION
CRAMER'S V	0.35846		
CONTINGENCY COEFFICIENT	0.58266		

METHODOLOGY BY PATTERNS OF CHANGE

PATTERNS OF CHANGE

METHODOLOGY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	inductivism 1.00	contextualism b 3.00	contextualism a 4.00	relativism 5.00	eclectic 10.00	missing answers 11.00	ROW TOTAL
1.00 inductivism	COUNT	1	11	1	3	0	0	16
	EXP VAL	1.2	5.7	2.9	.7	5.4	.2	16.8%
	ROW PCT	6.3%	68.8%	6.3%	18.8%	.0%	.0%	
	COL PCT	14.3%	32.4%	5.9%	75.0%	.0%	.0%	
	TOT PCT	1.1%	11.6%	1.1%	3.2%	.0%	.0%	
	RESIDUAL	-.2	5.3	-1.9	2.3	-5.4	-.2	
	STD RES	-.2	2.2	-1.1	2.8	-2.3	-.4	
	ADJ RES	-.2	3.0	-1.3	3.2	-3.1	-.5	
2.00 deductivism	COUNT	1	3	0	0	1	0	5
	EXP VAL	.4	1.8	.9	.2	1.7	.1	5.3%
	ROW PCT	20.0%	60.0%	.0%	.0%	20.0%	.0%	
	COL PCT	14.3%	8.8%	.0%	.0%	3.1%	.0%	
	TOT PCT	1.1%	3.2%	.0%	.0%	1.1%	.0%	
	RESIDUAL	.6	1.2	-.9	-.2	-.7	-.1	
	STD RES	1.0	.9	-.9	-.5	-.5	-.2	
	ADJ RES	1.1	1.2	-1.1	-.5	-.7	-.2	
3.00 cont B-cont A	COUNT	1	5	4	0	11	1	22
	EXP VAL	1.6	7.9	3.9	.9	7.4	.2	23.2%
	ROW PCT	4.5%	22.7%	18.2%	.0%	50.0%	4.5%	
	COL PCT	14.3%	14.7%	23.5%	.0%	34.4%	100.0%	
	TOT PCT	1.1%	5.3%	4.2%	.0%	11.6%	1.1%	
	RESIDUAL	-.6	-2.9	.1	-.9	3.6	.8	
	STD RES	-.5	-1.0	.0	-1.0	1.3	1.6	
	ADJ RES	-.6	-1.5	.0	-1.1	1.8	1.8	
4.00 undec. rational	COUNT	0	4	6	0	2	0	12
	EXP VAL	.9	4.3	2.1	.5	4.0	.1	12.6%
	ROW PCT	.0%	33.3%	50.0%	.0%	16.7%	.0%	
	COL PCT	.0%	11.8%	35.3%	.0%	6.3%	.0%	
	TOT PCT	.0%	4.2%	6.3%	.0%	2.1%	.0%	
	RESIDUAL	-.9	-.3	3.9	-.5	-2.0	-.1	
	STD RES	-.9	-.1	2.6	-.7	-1.0	-.4	
	ADJ RES	-1.0	-.2	3.1	-.8	-1.3	-.4	
10.00 eclectic	COUNT	4	11	6	1	18	0	40
	EXP VAL	2.9	14.3	7.2	1.7	13.5	.4	42.1%
	ROW PCT	10.0%	27.5%	15.0%	2.5%	45.0%	.0%	
	COL PCT	57.1%	32.4%	35.3%	25.0%	56.3%	.0%	
	TOT PCT	4.2%	11.6%	6.3%	1.1%	18.9%	.0%	
	RESIDUAL	1.1	-3.3	-1.2	-.7	4.5	-.4	
	STD RES	.6	-.9	-.4	-.5	1.2	-.6	
	ADJ RES	.8	-1.4	-.6	-.7	2.0	-.9	
COLUMN TOTAL		7	34	17	4	32	1	95
		7.4%	35.8%	17.9%	4.2%	33.7%	1.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
42.55789	20	0.0023	0.053	23 OF 30 (76.7%)

STATISTIC	VALUE	WITH METHODOLOGY SIGNIFICANCE	WITH PATTERNS OF CHANGE
CRAMER'S V	0.33466		
CONTINGENCY COEFFICIENT	0.55622		

METHODOLOGY BY ISSUE OF REALITY

METHODOLOGY	ISSUE OF REALITY: COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	pragmatism 2.00	sc. realism 3.00	idealism 4.00	scepticism 5.00	eclectic 10.00	ROW TOTAL
1.00 inductivism	COUNT	0	4	5	0	7	16
	EXP VAL	.2	6.4	3.5	.5	5.4	16.8%
	ROW PCT	.0%	25.0%	31.3%	.0%	43.8%	
	COL PCT	.0%	10.5%	23.8%	.0%	21.9%	
	TOT PCT	.0%	4.2%	5.3%	.0%	7.4%	
	RESIDUAL	-.2	-2.4	1.5	-.5	1.6	
	STD RES	-.4	-.9	.8	-.7	.7	
	ADJ RES	-.5	-1.3	1.0	-.8	.9	
2.00 deductivism	COUNT	0	1	3	0	1	5
	EXP VAL	.1	2.0	1.1	.2	1.7	5.3%
	ROW PCT	.0%	20.0%	60.0%	.0%	20.0%	
	COL PCT	.0%	2.6%	14.3%	.0%	3.1%	
	TOT PCT	.0%	1.1%	3.2%	.0%	1.1%	
	RESIDUAL	-.1	-1.0	1.9	-.2	-.7	
	STD RES	-.2	-.7	1.8	-.4	-.5	
	ADJ RES	-.2	-.9	2.1	-.4	-.7	
3.00 cont B-cont A	COUNT	0	10	3	1	8	22
	EXP VAL	.2	8.8	4.9	.7	7.4	23.2%
	ROW PCT	.0%	45.5%	13.6%	4.5%	36.4%	
	COL PCT	.0%	26.3%	14.3%	33.3%	25.0%	
	TOT PCT	.0%	10.5%	3.2%	1.1%	8.4%	
	RESIDUAL	-.2	1.2	-1.9	.3	.6	
	STD RES	-.5	.4	-.8	.4	.2	
	ADJ RES	-.6	.6	-1.1	.4	.3	
4.00 undec. rational	COUNT	0	4	3	0	5	12
	EXP VAL	.1	4.8	2.7	.4	4.0	12.6%
	ROW PCT	.0%	33.3%	25.0%	.0%	41.7%	
	COL PCT	.0%	10.5%	14.3%	.0%	15.6%	
	TOT PCT	.0%	4.2%	3.2%	.0%	5.3%	
	RESIDUAL	-.1	-.8	.3	-.4	1.0	
	STD RES	-.4	-.4	.2	-.6	.5	
	ADJ RES	-.4	-.5	.3	-.7	.6	
10.00 eclectic	COUNT	1	19	7	2	11	40
	EXP VAL	.4	16.0	8.8	1.3	13.5	42.1%
	ROW PCT	2.5%	47.5%	17.5%	5.0%	27.5%	
	COL PCT	100.0%	50.0%	33.3%	66.7%	34.4%	
	TOT PCT	1.1%	20.0%	7.4%	2.1%	11.6%	
	RESIDUAL	.6	3.0	-1.8	.7	-2.5	
	STD RES	.9	.8	-.6	.7	-.7	
	ADJ RES	1.2	1.3	-.9	.9	-1.1	
COLUMN TOTAL		1	38	21	3	32	95
		1.1%	40.0%	22.1%	3.2%	33.7%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
11.72429	16	0.7627	0.053	18 OF 25 (72.0%)

WITH METHODOLOGY WITH ISSUE OF REALITY

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.17565	
CONTINGENCY COEFFICIENT	0.33145	

METHODOLOGY BY SC. KNOWLEDGE STATUS

METHODOLOGY	SC. KNOWLEDGE STATUS: COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	prag-con t b 2.00	undec. rational 3.00	relat-cont a 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	1	1	14	0	16
	EXP VAL	1.2	2.4	8.8	3.7	16.8%
	ROW PCT	6.3%	6.3%	87.5%	.0%	
	COL PCT	14.3%	7.1%	26.9%	.0%	
	TOT PCT	1.1%	1.1%	14.7%	.0%	
	RESIDUAL	-.2	-1.4	5.2	-3.7	
	STD RES	-.2	-.9	1.8	-1.9	
	ADJ RES	-.2	-1.1	2.9	-2.4	
2.00 deductivism	COUNT	0	0	4	1	5
	EXP VAL	.4	.7	2.7	1.2	5.3%
	ROW PCT	.0%	.0%	80.0%	20.0%	
	COL PCT	.0%	.0%	7.7%	4.5%	
	TOT PCT	.0%	.0%	4.2%	1.1%	
	RESIDUAL	-.4	-.7	1.3	-.2	
	STD RES	-.6	-.9	.8	-.1	
	ADJ RES	-.6	-1.0	1.2	-.2	
3.00 cont B-cont A	COUNT	3	7	9	3	22
	EXP VAL	1.6	3.2	12.0	5.1	23.2%
	ROW PCT	13.6%	31.8%	40.9%	13.6%	
	COL PCT	42.9%	50.0%	17.3%	13.6%	
	TOT PCT	3.2%	7.4%	9.5%	3.2%	
	RESIDUAL	1.4	3.8	-3.0	-2.1	
	STD RES	1.1	2.1	-.9	-.9	
	ADJ RES	1.3	2.6	-1.5	-1.2	
4.00 undec. rational	COUNT	1	3	4	4	12
	EXP VAL	.9	1.8	6.6	2.8	12.6%
	ROW PCT	8.3%	25.0%	33.3%	33.3%	
	COL PCT	14.3%	21.4%	7.7%	18.2%	
	TOT PCT	1.1%	3.2%	4.2%	4.2%	
	RESIDUAL	.1	1.2	-2.6	1.2	
	STD RES	.1	.9	-1.0	.7	
	ADJ RES	.1	1.1	-1.6	.9	
10.00 eclectic	COUNT	2	3	21	14	40
	EXP VAL	2.9	5.9	21.9	9.3	42.1%
	ROW PCT	5.0%	7.5%	52.5%	35.0%	
	COL PCT	28.6%	21.4%	40.4%	63.6%	
	TOT PCT	2.1%	3.2%	22.1%	14.7%	
	RESIDUAL	-.9	-2.9	-.9	4.7	
	STD RES	-.6	-1.2	-.2	1.6	
	ADJ RES	-.8	-1.7	-.4	2.3	
COLUMN TOTAL		7	14	52	22	95
		7.4%	14.7%	54.7%	23.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
23.11899	12	0.0267	0.368	13 OF 20 (65.0%)

WITH METHODOLOGY WITH SC. KNOWLEDGE STATUS

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.28481	
CONTINGENCY COEFFICIENT	0.44241	

METHODOLOGY BY "CONTENT" AND "PROCESS"

METHODOLOGY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rel.-law s-exp 1.00	rel-fact s-meth 2.00	rel-fact s-exp 3.00	dist-fac ts-exp 4.00	dist-fac ts-meth 5.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	1	14	0	0	1	16
	EXP VAL	.7	3.4	7.1	1.2	1.7	2.0	16.8%
	ROW PCT	.0%	6.3%	87.5%	.0%	.0%	6.3%	
	COL PCT	.0%	5.0%	33.3%	.0%	.0%	8.3%	
	TOT PCT	.0%	1.1%	14.7%	.0%	.0%	1.1%	
	RESIDUAL	-.7	-2.4	6.9	-1.2	-1.7	-1.0	
	STD RES	-.8	-1.3	2.6	-1.1	-1.3	-.7	
	ADJ RES	-.9	-1.6	3.8	-1.2	-1.5	-.8	
2.00 deductivism	COUNT	0	0	4	0	1	0	5
	EXP VAL	.2	1.1	2.2	.4	.5	.6	5.3%
	ROW PCT	.0%	.0%	80.0%	.0%	20.0%	.0%	
	COL PCT	.0%	.0%	9.5%	.0%	10.0%	.0%	
	TOT PCT	.0%	.0%	4.2%	.0%	1.1%	.0%	
	RESIDUAL	-.2	-1.1	1.8	-.4	.5	-.6	
	STD RES	-.5	-1.0	1.2	-.6	.7	-.8	
	ADJ RES	-.5	-1.2	1.7	-.6	.7	-.9	
3.00 cont B-cont A	COUNT	0	6	5	2	5	4	22
	EXP VAL	.9	4.6	9.7	1.6	2.3	2.8	23.2%
	ROW PCT	.0%	27.3%	22.7%	9.1%	22.7%	18.2%	
	COL PCT	.0%	30.0%	11.9%	28.6%	50.0%	33.3%	
	TOT PCT	.0%	6.3%	5.3%	2.1%	5.3%	4.2%	
	RESIDUAL	-.9	1.4	-4.7	.4	2.7	1.2	
	STD RES	-1.0	.6	-1.5	.3	1.8	.7	
	ADJ RES	-1.1	.8	-2.3	.4	2.1	.9	
4.00 undec. rational	COUNT	3	1	5	0	3	0	12
	EXP VAL	.5	2.5	5.3	.9	1.3	1.5	12.6%
	ROW PCT	25.0%	8.3%	41.7%	.0%	25.0%	.0%	
	COL PCT	75.0%	5.0%	11.9%	.0%	30.0%	.0%	
	TOT PCT	3.2%	1.1%	5.3%	.0%	3.2%	.0%	
	RESIDUAL	2.5	-1.5	-.3	-.9	1.7	-1.5	
	STD RES	3.5	-1.0	-.1	-.9	1.5	-1.2	
	ADJ RES	3.8	-1.2	-.2	-1.0	1.7	-1.4	
10.00 eclectic	COUNT	1	12	14	5	1	7	40
	EXP VAL	1.7	8.4	17.7	2.9	4.2	5.1	42.1%
	ROW PCT	2.5%	30.0%	35.0%	12.5%	2.5%	17.5%	
	COL PCT	25.0%	60.0%	33.3%	71.4%	10.0%	58.3%	
	TOT PCT	1.1%	12.6%	14.7%	5.3%	1.1%	7.4%	
	RESIDUAL	-.7	3.6	-3.7	2.1	-3.2	1.9	
	STD RES	-.5	1.2	-.9	1.2	-1.6	.9	
	ADJ RES	-.7	1.8	-1.5	1.6	-2.2	1.2	
COLUMN TOTAL		4	20	42	7	10	12	95
		4.2%	21.1%	44.2%	7.4%	10.5%	12.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
49.24199	20	0.0003	0.211	24 OF 30 (80.0%)

WITH METHODOLOGY WITH "CONTENT" AND "PROCESS"

STATISTIC	VALUE	SIGNIFICANCE
RAMER'S V	0.35998	
ONTINGENCY COEFFICIENT	0.58428	

CROSSTABULATION OF METHODOLOGY BY INTEGRATION

METHODOLOGY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	sep-cont I-prac 1.00	sep-else sr 2.00	int-c-m- 3.00	int-prac 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	4	3	6	0	3	16
	EXP VAL	3.9	1.3	5.7	3.2	1.9	16.8%
	ROW PCT	25.0%	18.8%	37.5%	.0%	18.8%	
	COL PCT	17.4%	37.5%	17.6%	.0%	27.3%	
	TOT PCT	4.2%	3.2%	6.3%	.0%	3.2%	
	RESIDUAL	.1	1.7	.3	-3.2	1.1	
	STD RES	.1	1.4	.1	-1.8	.8	
	ADJ RES	.1	1.6	.2	-2.2	1.0	
2.00 deductivism	COUNT	0	0	1	4	0	5
	EXP VAL	1.2	.4	1.8	1.0	.6	5.3%
	ROW PCT	.0%	.0%	20.0%	80.0%	.0%	
	COL PCT	.0%	.0%	2.9%	21.1%	.0%	
	TOT PCT	.0%	.0%	1.1%	4.2%	.0%	
	RESIDUAL	-1.2	-.4	-.8	3.0	-.6	
	STD RES	-1.1	-.6	-.6	3.0	-.8	
	ADJ RES	-1.3	-.7	-.8	3.4	-.8	
3.00 cont B-cont A	COUNT	4	0	8	8	2	22
	EXP VAL	5.3	1.9	7.9	4.4	2.5	23.2%
	ROW PCT	18.2%	.0%	36.4%	36.4%	9.1%	
	COL PCT	17.4%	.0%	23.5%	42.1%	18.2%	
	TOT PCT	4.2%	.0%	8.4%	8.4%	2.1%	
	RESIDUAL	-1.3	-1.9	.1	3.6	-.5	
	STD RES	-.6	-1.4	.0	1.7	-.3	
	ADJ RES	-.8	-1.6	.1	2.2	-.4	
4.00 undec. rational	COUNT	3	1	7	1	0	12
	EXP VAL	2.9	1.0	4.3	2.4	1.4	12.6%
	ROW PCT	25.0%	8.3%	58.3%	8.3%	.0%	
	COL PCT	13.0%	12.5%	20.6%	5.3%	.0%	
	TOT PCT	3.2%	1.1%	7.4%	1.1%	.0%	
	RESIDUAL	.1	.0	2.7	-1.4	-1.4	
	STD RES	.1	.0	1.3	-.9	-1.2	
	ADJ RES	.1	.0	1.7	-1.1	-1.3	
10.00 eclectic	COUNT	12	4	12	6	6	40
	EXP VAL	9.7	3.4	14.3	8.0	4.6	42.1%
	ROW PCT	30.0%	10.0%	30.0%	15.0%	15.0%	
	COL PCT	52.2%	50.0%	35.3%	31.6%	54.5%	
	TOT PCT	12.6%	4.2%	12.6%	6.3%	6.3%	
	RESIDUAL	2.3	.6	-2.3	-2.0	1.4	
	STD RES	.7	.3	-.6	-.7	.6	
	ADJ RES	1.1	.5	-1.0	-1.0	.9	
COLUMN TOTAL		23	8	34	19	11	95
		24.2%	8.4%	35.8%	20.0%	11.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
28.62616	16	0.0266	0.421	19 OF 25 (76.0%)

WITH METHODOLOGY WITH INTEGRATION

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.27447	
CONTINGENCY COEFFICIENT	0.48120	

CROSSTABULATION OF METHODOLOGY BY INSTRUCTION ASSUMPTIONS

INSTRUCTION ASSUMPTIONS

Cell contents: COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

METHODOLOGY		tech.sm. occ.part 1.00	bal.sm.i nteg.par 2.00	bal.sm.o cc.part 3.00	bal.sm.i nteg.emo 4.00	bal.sm.o cc.emot 5.00	bal.id.o cc.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	2	8	3	0	1	0	2	16
	EXP VAL	.8	1.5	2.7	1.7	2.0	2.4	.5	4.4	16.8%
	ROW PCT	.0%	12.5%	50.0%	18.8%	.0%	6.3%	.0%	12.5%	
	COL PCT	.0%	22.2%	50.0%	30.0%	.0%	7.1%	.0%	7.7%	
	TOT PCT	.0%	2.1%	8.4%	3.2%	.0%	1.1%	.0%	2.1%	
	RESIDUAL	-.8	.5	5.3	1.3	-2.0	-1.4	-.5	-2.4	
	STD RES	-.9	.4	3.2	1.0	-1.4	-.9	-.7	-1.1	
	ADJ RES	-1.0	.5	3.9	1.2	-1.7	-1.1	-.8	-1.3	
2.00 deductivism	COUNT	0	0	1	3	0	0	1	0	5
	EXP VAL	.3	.5	.8	.5	.6	.7	.2	1.4	5.3%
	ROW PCT	.0%	.0%	20.0%	60.0%	.0%	.0%	20.0%	.0%	
	COL PCT	.0%	.0%	6.3%	30.0%	.0%	.0%	33.3%	.0%	
	TOT PCT	.0%	.0%	1.1%	3.2%	.0%	.0%	1.1%	.0%	
	RESIDUAL	-.3	-.5	.2	2.5	-.6	-.7	.8	-1.4	
	STD RES	-.5	-.7	.2	3.4	-.8	-.9	2.1	-1.2	
	ADJ RES	-.5	-.7	.2	3.7	-.9	-1.0	2.2	-1.4	
3.00 cont B-cont A	COUNT	0	6	1	0	0	6	0	9	22
	EXP VAL	1.2	2.1	3.7	2.3	2.8	3.2	.7	6.0	23.2%
	ROW PCT	.0%	27.3%	4.5%	.0%	.0%	27.3%	.0%	40.9%	
	COL PCT	.0%	66.7%	6.3%	.0%	.0%	42.9%	.0%	34.6%	
	TOT PCT	.0%	6.3%	1.1%	.0%	.0%	6.3%	.0%	9.5%	
	RESIDUAL	-1.2	3.9	-2.7	-2.3	-2.8	2.8	-.7	3.0	
	STD RES	-1.1	2.7	-1.4	-1.5	-1.7	1.5	-.8	1.2	
	ADJ RES	-1.3	3.3	-1.8	-1.8	-2.0	1.9	-1.0	1.6	
4.00 undec. rational	COUNT	3	0	1	1	4	3	0	0	12
	EXP VAL	.6	1.1	2.0	1.3	1.5	1.8	.4	3.3	12.6%
	ROW PCT	25.0%	.0%	8.3%	8.3%	33.3%	25.0%	.0%	.0%	
	COL PCT	60.0%	.0%	6.3%	10.0%	33.3%	21.4%	.0%	.0%	
	TOT PCT	3.2%	.0%	1.1%	1.1%	4.2%	3.2%	.0%	.0%	
	RESIDUAL	2.4	-1.1	-1.0	-.3	2.5	1.2	-.4	-3.3	
	STD RES	3.0	-1.1	-.7	-.2	2.0	.9	-.6	-1.8	
	ADJ RES	3.3	-1.2	-.8	-.3	2.3	1.1	-.7	-2.3	
10.00 eclectic	COUNT	2	1	5	3	8	4	2	15	40
	EXP VAL	2.1	3.8	6.7	4.2	5.1	5.9	1.3	10.9	42.1%
	ROW PCT	5.0%	2.5%	12.5%	7.5%	20.0%	10.0%	5.0%	37.5%	
	COL PCT	40.0%	11.1%	31.3%	30.0%	66.7%	28.6%	66.7%	57.7%	
	TOT PCT	2.1%	1.1%	5.3%	3.2%	8.4%	4.2%	2.1%	15.8%	
	RESIDUAL	-.1	-2.8	-1.7	-1.2	2.9	-1.9	.7	4.1	
	STD RES	-.1	-1.4	-.7	-.6	1.3	-.8	.7	1.2	
	ADJ RES	-.1	-2.0	-1.0	-.8	1.8	-1.1	.9	1.9	
COLUMN TOTAL		5	9	16	10	12	14	3	26	95
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
83.08445	28	0.0000	0.158	35 OF 40 (87.5%)

STATISTIC	VALUE	WITH METHODOLOGY SIGNIFICANCE	WITH INSTRUCTION ASSUMPTIONS
CRAMER'S V	0.46759		
CONTINGENCY COEFFICIENT	0.68304		

CROSSTABULATION OF METHODOLOGY BY LEARNING ASSUMPTIONS

LEARNING ASSUMPTIONS

Cell contents: COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

METHODOLOGY		cognitive 1.00	behaviour. 2.00	phenomen 3.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	11	1	0	4	16
	EXP VAL	4.4	1.9	2.7	7.1	16.8%
	ROW PCT	68.8%	6.3%	.0%	25.0%	
	COL PCT	42.3%	9.1%	.0%	9.5%	
	TOT PCT	11.6%	1.1%	.0%	4.2%	
	RESIDUAL	6.6	-.9	-2.7	-3.1	
	STD RES	3.2	-.6	-1.6	-1.2	
	ADJ RES	4.1	-.7	-2.0	-1.7	
2.00 deductivism	COUNT	3	0	2	0	5
	EXP VAL	1.4	.6	.8	2.2	5.3%
	ROW PCT	60.0%	.0%	40.0%	.0%	
	COL PCT	11.5%	.0%	12.5%	.0%	
	TOT PCT	3.2%	.0%	2.1%	.0%	
	RESIDUAL	1.6	-.6	1.2	-2.2	
	STD RES	1.4	-.8	1.3	-1.5	
	ADJ RES	1.7	-.8	1.4	-2.0	
3.00 cont B-cont A	COUNT	2	4	2	14	22
	EXP VAL	6.0	2.5	3.7	9.7	23.2%
	ROW PCT	9.1%	18.2%	9.1%	63.6%	
	COL PCT	7.7%	36.4%	12.5%	33.3%	
	TOT PCT	2.1%	4.2%	2.1%	14.7%	
	RESIDUAL	-4.0	1.5	-1.7	4.3	
	STD RES	-1.6	.9	-.9	1.4	
	ADJ RES	-2.2	1.1	-1.1	2.1	
4.00 undec. rational	COUNT	1	1	4	6	12
	EXP VAL	3.3	1.4	2.0	5.3	12.6%
	ROW PCT	8.3%	8.3%	33.3%	50.0%	
	COL PCT	3.8%	9.1%	25.0%	14.3%	
	TOT PCT	1.1%	1.1%	4.2%	6.3%	
	RESIDUAL	-2.3	-.4	2.0	.7	
	STD RES	-1.3	-.3	1.4	.3	
	ADJ RES	-1.6	-.4	1.6	.4	
10.00 eclectic	COUNT	9	5	8	18	40
	EXP VAL	10.9	4.6	6.7	17.7	42.1%
	ROW PCT	22.5%	12.5%	20.0%	45.0%	
	COL PCT	34.6%	45.5%	50.0%	42.9%	
	TOT PCT	9.5%	5.3%	8.4%	18.9%	
	RESIDUAL	-1.9	.4	1.3	.3	
	STD RES	-.6	.2	.5	.1	
	ADJ RES	-.9	.2	.7	.1	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
31.28195	12	0.0018	0.579	13 OF 20 (65.0%)

STATISTIC	VALUE	WITH METHODOLOGY SIGNIFICANCE	WITH LEARNING ASSUMPTIONS
CRAMER'S V	0.33130		
CONTINGENCY COEFFICIENT	0.49771		

DEMARCATION BY PATTERNS OF CHANGE

PATTERNS OF CHANGE

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	inductivism 1.00	contextualism b 3.00	contextualism a 4.00	relativism 5.00	eclectic 10.00	missing answers 11.00	ROW TOTAL
1.00 "truth"	COUNT	1	6	1	0	3	0	11
	EXP VAL	.8	3.9	2.0	.5	3.7	.1	11.6%
	ROW PCT	9.1%	54.5%	9.1%	.0%	27.3%	.0%	
	COL PCT	14.3%	17.6%	5.9%	.0%	9.4%	.0%	
	TOT PCT	1.1%	6.3%	1.1%	.0%	3.2%	.0%	
	RESIDUAL	.2	2.1	-1.0	-.5	-.7	-.1	
	STD RES	.2	1.0	-.7	-.7	-.4	-.3	
	ADJ RES	.2	1.4	-.8	-.7	-.5	-.4	
2.00 cont B/pragm	COUNT	1	8	6	3	11	0	29
	EXP VAL	2.1	10.4	5.2	1.2	9.8	.3	30.5%
	ROW PCT	3.4%	27.6%	20.7%	10.3%	37.9%	.0%	
	COL PCT	14.3%	23.5%	35.3%	75.0%	34.4%	.0%	
	TOT PCT	1.1%	8.4%	6.3%	3.2%	11.6%	.0%	
	RESIDUAL	-1.1	-2.4	.8	1.8	1.2	-.3	
	STD RES	-.8	-.7	.4	1.6	.4	-.6	
	ADJ RES	-1.0	-1.1	.5	2.0	.6	-.7	
3.00 undecided rat	COUNT	0	0	4	0	3	0	7
	EXP VAL	.5	2.5	1.3	.3	2.4	.1	7.4%
	ROW PCT	.0%	.0%	57.1%	.0%	42.9%	.0%	
	COL PCT	.0%	.0%	23.5%	.0%	9.4%	.0%	
	TOT PCT	.0%	.0%	4.2%	.0%	3.2%	.0%	
	RESIDUAL	-.5	-2.5	2.7	-.3	.6	-.1	
	STD RES	-.7	-1.6	2.5	-.5	.4	-.3	
	ADJ RES	-.8	-2.1	2.8	-.6	.5	-.3	
4.00 cont A/rel	COUNT	1	7	0	0	3	0	11
	EXP VAL	.8	3.9	2.0	.5	3.7	.1	11.6%
	ROW PCT	9.1%	63.6%	.0%	.0%	27.3%	.0%	
	COL PCT	14.3%	20.6%	.0%	.0%	9.4%	.0%	
	TOT PCT	1.1%	7.4%	.0%	.0%	3.2%	.0%	
	RESIDUAL	.2	3.1	-2.0	-.5	-.7	-.1	
	STD RES	.2	1.5	-1.4	-.7	-.4	-.3	
	ADJ RES	.2	2.0	-1.6	-.7	-.5	-.4	
10.00	COUNT	4	13	6	1	12	1	37
	EXP VAL	2.7	13.2	6.6	1.6	12.5	.4	38.9%
	ROW PCT	10.8%	35.1%	16.2%	2.7%	32.4%	2.7%	
	COL PCT	57.1%	38.2%	35.3%	25.0%	37.5%	100.0%	
	TOT PCT	4.2%	13.7%	6.3%	1.1%	12.6%	1.1%	
	RESIDUAL	1.3	-.2	-.6	-.6	-.5	.6	
	STD RES	.8	-.1	-.2	-.4	-.1	1.0	
	ADJ RES	1.0	-.1	-.3	-.6	-.2	1.3	
COLUMN TOTAL		7	34	17	4	32	1	95
		7.4%	35.8%	17.9%	4.2%	33.7%	1.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
23.17522	20	0.2803	0.074	24 OF 30 (80.0%)

STATISTIC	VALUE	SIGNIFICANCE WITH DEMARCATION	SIGNIFICANCE WITH PATTERNS OF CHANGE
CRAMER'S V	0.24696		
CONTINGENCY COEFFICIENT	0.44284		

METHODOLOGY BY CLASSROOM ACTIVITIES

CLASSROOM ACTIVITIES

METHODOLOGY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	7	8	0	0	1	16
	EXP VAL	7.6	4.4	1.2	2.5	.3	16.8%
	ROW PCT	43.8%	50.0%	.0%	.0%	6.3%	
	COL PCT	15.6%	30.8%	.0%	.0%	50.0%	
	TOT PCT	7.4%	8.4%	.0%	.0%	1.1%	
	RESIDUAL	-.6	3.6	-1.2	-2.5	.7	
	STD RES	-.2	1.7	-1.1	-1.6	1.1	
	ADJ RES	-.3	2.2	-1.2	-1.9	1.3	
2.00 deductivism	COUNT	0	4	0	1	0	5
	EXP VAL	2.4	1.4	.4	.8	.1	5.3%
	ROW PCT	.0%	80.0%	.0%	20.0%	.0%	
	COL PCT	.0%	15.4%	.0%	6.7%	.0%	
	TOT PCT	.0%	4.2%	.0%	1.1%	.0%	
	RESIDUAL	-2.4	2.6	-.4	.2	-.1	
	STD RES	-1.5	2.2	-.6	.2	-.3	
	ADJ RES	-2.2	2.7	-.6	.3	-.3	
3.00 cont B-cont A	COUNT	11	6	1	4	0	22
	EXP VAL	10.4	6.0	1.6	3.5	.5	23.2%
	ROW PCT	50.0%	27.3%	4.5%	18.2%	.0%	
	COL PCT	24.4%	23.1%	14.3%	26.7%	.0%	
	TOT PCT	11.6%	6.3%	1.1%	4.2%	.0%	
	RESIDUAL	.6	.0	-.6	.5	-.5	
	STD RES	.2	.0	-.5	.3	-.7	
	ADJ RES	.3	.0	-.6	.4	-.8	
4.00 undec. rational	COUNT	6	0	3	3	0	12
	EXP VAL	5.7	3.3	.9	1.9	.3	12.6%
	ROW PCT	50.0%	.0%	25.0%	25.0%	.0%	
	COL PCT	13.3%	.0%	42.9%	20.0%	.0%	
	TOT PCT	6.3%	.0%	3.2%	3.2%	.0%	
	RESIDUAL	.3	-3.3	2.1	1.1	-.3	
	STD RES	.1	-1.8	2.3	.8	-.5	
	ADJ RES	.2	-2.3	2.5	.9	-.5	
10.00 eclectic	COUNT	21	8	3	7	1	40
	EXP VAL	18.9	10.9	2.9	6.3	.8	42.1%
	ROW PCT	52.5%	20.0%	7.5%	17.5%	2.5%	
	COL PCT	46.7%	30.8%	42.9%	46.7%	50.0%	
	TOT PCT	22.1%	8.4%	3.2%	7.4%	1.1%	
	RESIDUAL	2.1	-2.9	.1	.7	.2	
	STD RES	.5	-.9	.0	.3	.2	
	ADJ RES	.9	-1.4	.0	.4	.2	
COLUMN TOTAL		45	26	7	15	2	95
		47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
27.20392	16	0.0393	0.105	18 OF 25 (72.0%)

STATISTIC	VALUE	SIGNIFICANCE WITH METHODOLOGY	SIGNIFICANCE WITH CLASSROOM ACTIVITIES
CRAMER'S V	0.26756		
CONTINGENCY COEFFICIENT	0.47182		

DEMARCATION BY ISSUE OF REALITY

ISSUE OF REALITY

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	pragmatism 2.00	sc. realism 3.00	idealism 4.00	scepticism 5.00	eclectic 10.00	ROW TOTAL
1.00 "truth"	COUNT	0	4	2	0	5	11
	EXP VAL	.1	4.4	2.4	.3	3.7	11.6%
	ROW PCT	.0%	36.4%	18.2%	.0%	45.5%	
	COL PCT	.0%	10.5%	9.5%	.0%	15.6%	
	TOT PCT	.0%	4.2%	2.1%	.0%	5.3%	
	RESIDUAL	-.1	-.4	-.4	-.3	1.3	
	STD RES	-.3	-.2	-.3	-.6	.7	
	ADJ RES	-.4	-.3	-.3	-.6	.9	
2.00 cont B/pragm	COUNT	1	10	7	1	10	29
	EXP VAL	.3	11.6	6.4	.9	9.8	30.5%
	ROW PCT	3.4%	34.5%	24.1%	3.4%	34.5%	
	COL PCT	100.0%	26.3%	33.3%	33.3%	31.3%	
	TOT PCT	1.1%	10.5%	7.4%	1.1%	10.5%	
	RESIDUAL	.7	-1.6	.6	.1	.2	
	STD RES	1.3	-.5	.2	.1	.1	
	ADJ RES	1.5	-.7	.3	.1	.1	
3.00 undecided rat	COUNT	0	4	0	0	3	7
	EXP VAL	.1	2.8	1.5	.2	2.4	7.4%
	ROW PCT	.0%	57.1%	.0%	.0%	42.9%	
	COL PCT	.0%	10.5%	.0%	.0%	9.4%	
	TOT PCT	.0%	4.2%	.0%	.0%	3.2%	
	RESIDUAL	-.1	1.2	-1.5	-.2	.6	
	STD RES	-.3	.7	-1.2	-.5	.4	
	ADJ RES	-.3	1.0	-1.5	-.5	.5	
4.00 cont A/rel	COUNT	0	6	4	0	1	11
	EXP VAL	.1	4.4	2.4	.3	3.7	11.6%
	ROW PCT	.0%	54.5%	36.4%	.0%	9.1%	
	COL PCT	.0%	15.8%	19.0%	.0%	3.1%	
	TOT PCT	.0%	6.3%	4.2%	.0%	1.1%	
	RESIDUAL	-.1	1.6	1.6	-.3	-2.7	
	STD RES	-.3	.8	1.0	-.6	-1.4	
	ADJ RES	-.4	1.0	1.2	-.6	-1.8	
10.00	COUNT	0	14	8	2	13	37
	EXP VAL	.4	14.8	8.2	1.2	12.5	38.9%
	ROW PCT	.0%	37.8%	21.6%	5.4%	35.1%	
	COL PCT	.0%	36.8%	38.1%	66.7%	40.6%	
	TOT PCT	.0%	14.7%	8.4%	2.1%	13.7%	
	RESIDUAL	-.4	-.8	-.2	.8	.5	
	STD RES	-.6	-.2	-.1	.8	.2	
	ADJ RES	-.8	-.3	-.1	1.0	.2	
COLUMN TOTAL		1	38	21	3	32	95
		1.1%	40.0%	22.1%	3.2%	33.7%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
10.51244	16	0.8385	0.074	19 OF 25 (76.0%)

WITH DEMARCATION WITH ISSUE OF REALITY

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.16633	
CONTINGENCY COEFFICIENT	0.31565	

DEMARCATION BY SC. KNOWLEDGE STATUS

SC. KNOWLEDGE STATUS

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	prag-con lt b 2.00	undec. rational 3.00	relat-cont a 4.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	1	2	6	2	11
	EXP VAL	.8	1.6	6.0	2.5	11.6%
	ROW PCT	9.1%	18.2%	54.5%	18.2%	
	COL PCT	14.3%	14.3%	11.5%	9.1%	
	TOT PCT	1.1%	2.1%	6.3%	2.1%	
	RESIDUAL	.2	.4	.0	-.5	
	STD RES	.2	.3	.0	-.3	
	ADJ RES	.2	.3	.0	-.4	
2.00 cont B/pragm	COUNT	1	5	12	11	29
	EXP VAL	2.1	4.3	15.9	6.7	30.5%
	ROW PCT	3.4%	17.2%	41.4%	37.9%	
	COL PCT	14.3%	35.7%	23.1%	50.0%	
	TOT PCT	1.1%	5.3%	12.6%	11.6%	
	RESIDUAL	-1.1	.7	-3.9	4.3	
	STD RES	-.8	.4	-1.0	1.7	
	ADJ RES	-1.0	.5	-1.7	2.3	
3.00 undecided rat	COUNT	3	3	1	0	7
	EXP VAL	.5	1.0	3.8	1.6	7.4%
	ROW PCT	42.9%	42.9%	14.3%	.0%	
	COL PCT	42.9%	21.4%	1.9%	.0%	
	TOT PCT	3.2%	3.2%	1.1%	.0%	
	RESIDUAL	2.5	2.0	-2.8	-1.6	
	STD RES	3.5	1.9	-1.4	-1.3	
	ADJ RES	3.7	2.2	-2.2	-1.5	
4.00 cont A/rel	COUNT	0	0	10	1	11
	EXP VAL	.8	1.6	6.0	2.5	11.6%
	ROW PCT	.0%	.0%	90.9%	9.1%	
	COL PCT	.0%	.0%	19.2%	4.5%	
	TOT PCT	.0%	.0%	10.5%	1.1%	
	RESIDUAL	-.8	-1.6	4.0	-1.5	
	STD RES	-.9	-1.3	1.6	-1.0	
	ADJ RES	-1.0	-1.5	2.6	-1.2	
10.00	COUNT	2	4	23	8	37
	EXP VAL	2.7	5.5	20.3	8.6	38.9%
	ROW PCT	5.4%	10.8%	62.2%	21.6%	
	COL PCT	28.6%	28.6%	44.2%	36.4%	
	TOT PCT	2.1%	4.2%	24.2%	8.4%	
	RESIDUAL	-.7	-1.5	2.7	-.6	
	STD RES	-.4	-.6	.6	-.2	
	ADJ RES	-.6	-.9	1.2	-.3	
COLUMN TOTAL		7	14	52	22	95
		7.4%	14.7%	54.7%	23.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
31.08346	12	0.0019	0.516	13 OF 20 (65.0%)

WITH DEMARCATION WITH SC. KNOWLEDGE STATUS

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.33025	
CONTINGENCY COEFFICIENT	0.49652	

DEMARCATION BY "CONTENT" AND "PROCESS"

"CONTENT" AND "PROCESS"

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rel.-law s-emp 1.00	rel-fact meth 2.00	rel-fact s-emp 3.00	dist fac ts-emp 4.00	dist fac tr-meth 5.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	0	5	2	0	1	3	11
	EXP VAL	.5	2.3	4.9	.8	1.2	1.4	11.6%
	ROW PCT	.0%	45.5%	18.2%	.0%	9.1%	27.3%	
	COL PCT	.0%	25.0%	4.8%	.0%	10.0%	25.0%	
	TOT PCT	.0%	5.3%	2.1%	.0%	1.1%	3.2%	
	RESIDUAL	-.5	2.7	-2.9	-.8	-.2	1.6	
	STD RES	-.7	1.8	-1.3	-.9	-.1	1.4	
	ADJ RES	-.7	2.1	-1.8	-1.0	-.2	1.6	
2.00 cont B/pragm	COUNT	0	2	17	0	6	4	29
	EXP VAL	1.2	6.1	12.8	2.1	3.1	3.7	30.5%
	ROW PCT	.0%	6.9%	58.6%	.0%	20.7%	13.8%	
	COL PCT	.0%	10.0%	40.5%	.0%	60.0%	33.3%	
	TOT PCT	.0%	2.1%	17.9%	.0%	6.3%	4.2%	
	RESIDUAL	-1.2	-4.1	4.2	-2.1	2.9	.3	
	STD RES	-1.1	-1.7	1.2	-1.5	1.7	.2	
	ADJ RES	-1.4	-2.2	1.9	-1.8	2.1	.2	
3.00 undecided rat	COUNT	0	1	0	3	3	0	7
	EXP VAL	.3	1.5	3.1	.5	.7	.9	7.4%
	ROW PCT	.0%	14.3%	.0%	42.9%	42.9%	.0%	
	COL PCT	.0%	5.0%	.0%	42.9%	30.0%	.0%	
	TOT PCT	.0%	1.1%	.0%	3.2%	3.2%	.0%	
	RESIDUAL	-.3	-.5	-3.1	2.5	2.3	-.9	
	STD RES	-.5	-.4	-1.8	3.5	2.6	-.9	
	ADJ RES	-.6	-.5	-2.4	3.7	2.9	-1.0	
4.00 cont A/rel	COUNT	0	2	8	0	0	1	11
	EXP VAL	.5	2.3	4.9	.8	1.2	1.4	11.6%
	ROW PCT	.0%	18.2%	72.7%	.0%	.0%	9.1%	
	COL PCT	.0%	10.0%	19.0%	.0%	.0%	8.3%	
	TOT PCT	.0%	2.1%	8.4%	.0%	.0%	1.1%	
	RESIDUAL	-.5	-.3	3.1	-.8	-1.2	-.4	
	STD RES	-.7	-.2	1.4	-.9	-1.1	-.3	
	ADJ RES	-.7	-.2	2.0	-1.0	-1.2	-.4	
10.00	COUNT	4	10	15	4	0	4	37
	EXP VAL	1.6	7.8	16.4	2.7	3.9	4.7	38.9%
	ROW PCT	10.8%	27.0%	40.5%	10.8%	.0%	10.8%	
	COL PCT	100.0%	50.0%	35.7%	57.1%	.0%	33.3%	
	TOT PCT	4.2%	10.5%	15.8%	4.2%	.0%	4.2%	
	RESIDUAL	2.4	2.2	-1.4	1.3	-3.9	-.7	
	STD RES	2.0	.8	-.3	.8	-2.0	-.3	
	ADJ RES	2.6	1.1	-.6	1.0	-2.7	-.4	
COLUMN TOTAL		4	20	42	7	10	12	95
		4.2%	21.1%	44.2%	7.4%	10.5%	12.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
55.42006	20	0.0000	0.295	26 OF 30 (86.7%)

STATISTIC	VALUE	SIGNIFICANCE WITH DEMARCATION	WITH "CONTENT" AND "PROCESS"
CRAMER'S V	0.38189		
CONTINGENCY COEFFICIENT	0.60699		

DEMARCATION BY INTEGRATION

INTEGRATION

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	sep-cont-prac 1.00	sep-else 2.00	int-c-m-sr 3.00	int-prac 4.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	2	0	5	4	0	11
	EXP VAL	2.7	.9	3.9	2.2	1.3	11.6%
	ROW PCT	18.2%	.0%	45.5%	36.4%	.0%	
	COL PCT	8.7%	.0%	14.7%	21.1%	.0%	
	TOT PCT	2.1%	.0%	5.3%	4.2%	.0%	
	RESIDUAL	-.7	-.9	1.1	1.8	-1.3	
	STD RES	-.4	-1.0	.5	1.2	-1.1	
	ADJ RES	-.5	-1.1	.7	1.4	-1.3	
2.00 cont B/pragm	COUNT	11	2	7	3	6	29
	EXP VAL	7.0	2.4	10.4	5.8	3.4	30.5%
	ROW PCT	37.9%	6.9%	24.1%	10.3%	20.7%	
	COL PCT	47.8%	25.0%	20.6%	15.8%	54.5%	
	TOT PCT	11.6%	2.1%	7.4%	3.2%	6.3%	
	RESIDUAL	4.0	-.4	-3.4	-2.8	2.6	
	STD RES	1.5	-.3	-1.0	-1.2	1.4	
	ADJ RES	2.1	-.4	-1.6	-1.6	1.8	
3.00 undecided rat	COUNT	3	0	0	4	0	7
	EXP VAL	1.7	.6	2.5	1.4	.8	7.4%
	ROW PCT	42.9%	.0%	.0%	57.1%	.0%	
	COL PCT	13.0%	.0%	.0%	21.1%	.0%	
	TOT PCT	3.2%	.0%	.0%	4.2%	.0%	
	RESIDUAL	1.3	-.6	-2.5	2.6	-.8	
	STD RES	1.0	-.8	-1.6	2.2	-.9	
	ADJ RES	1.2	-.8	-2.1	2.6	-1.0	
4.00 cont A/rel	COUNT	4	1	2	3	1	11
	EXP VAL	2.7	.9	3.9	2.2	1.3	11.6%
	ROW PCT	36.4%	9.1%	18.2%	27.3%	9.1%	
	COL PCT	17.4%	12.5%	5.9%	15.8%	9.1%	
	TOT PCT	4.2%	1.1%	2.1%	3.2%	1.1%	
	RESIDUAL	1.3	.1	-1.9	.8	-.3	
	STD RES	.8	.1	-1.0	.5	-.2	
	ADJ RES	1.0	.1	-1.3	.6	-.3	
10.00	COUNT	3	5	20	5	4	37
	EXP VAL	9.0	3.1	13.2	7.4	4.3	38.9%
	ROW PCT	8.1%	13.5%	54.1%	13.5%	10.8%	
	COL PCT	13.0%	62.5%	58.8%	26.3%	36.4%	
	TOT PCT	3.2%	5.3%	21.1%	5.3%	4.2%	
	RESIDUAL	-6.0	1.9	6.8	-2.4	-.3	
	STD RES	-2.0	1.1	1.9	-.9	-.1	
	ADJ RES	-2.9	1.4	3.0	-1.3	-.2	
COLUMN TOTAL		23	8	34	19	11	95
		24.2%	8.4%	35.8%	20.0%	11.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
32.05731	16	0.0098	0.589	19 OF 25 (76.0%)

STATISTIC	VALUE	SIGNIFICANCE WITH DEMARCATION	WITH INTEGRATION
CRAMER'S V	0.29045		
CONTINGENCY COEFFICIENT	0.50230		

DEMARCATION BY INSTRUCTION ASSUMPTIONS

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	tech.sm.ioc.part 1.00	bal.sm.integ.par 2.00	bal.sm.o cc.part 3.00	bal.sn.i nteg.emo 4.00	bal.sm.o cc.emct 5.00	bal.id.o cc.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	0	0	1	0	0	3	2	5	11
	EXP VAL	.6	1.0	1.9	1.2	1.4	1.6	.3	3.0	11.6%
	ROW PCT	.0%	.0%	9.1%	.0%	.0%	27.3%	18.2%	45.5%	
	COL PCT	.0%	.0%	6.3%	.0%	.0%	21.4%	66.7%	19.2%	
	TOT PCT	.0%	.0%	1.1%	.0%	.0%	3.2%	2.1%	5.3%	
	RESIDUAL	-.6	-1.0	-.9	-1.2	-1.4	1.4	1.7	2.0	
	STD RES	-.8	-1.0	-.6	-1.1	-1.2	1.1	2.8	1.1	
	ADJ RES	-.8	-1.1	-.7	-1.2	-1.3	1.2	3.0	1.4	
2.00 cont B/pragm	COUNT	3	3	7	2	8	3	0	3	29
	EXP VAL	1.5	2.7	4.9	3.1	3.7	4.3	.9	7.9	30.5%
	ROW PCT	10.3%	10.3%	24.1%	6.9%	27.6%	10.3%	.0%	10.3%	
	COL PCT	60.0%	33.3%	43.8%	20.0%	66.7%	21.4%	.0%	11.5%	
	TOT PCT	3.2%	3.2%	7.4%	2.1%	8.4%	3.2%	.0%	3.2%	
	RESIDUAL	1.5	.3	2.1	-1.1	4.3	-1.3	-.9	-4.9	
	STD RES	1.2	.2	1.0	-.6	2.3	-.6	-1.0	-1.8	
	ADJ RES	1.5	.2	1.3	-.8	2.9	-.8	-1.2	-2.5	
3.00 undecided rat	COUNT	0	6	0	0	0	0	0	1	7
	EXP VAL	.4	.7	1.2	.7	.9	1.0	.2	1.9	7.4%
	ROW PCT	.0%	85.7%	.0%	.0%	.0%	.0%	.0%	14.3%	
	COL PCT	.0%	66.7%	.0%	.0%	.0%	.0%	.0%	3.8%	
	TOT PCT	.0%	6.3%	.0%	.0%	.0%	.0%	.0%	1.1%	
	RESIDUAL	-.4	5.3	-1.2	-.7	-.9	-1.0	-.2	-.9	
	STD RES	-.6	6.6	-1.1	-.9	-.9	-1.0	-.5	-.7	
	ADJ RES	-.6	7.2	-1.2	-.9	-1.0	-1.1	-.5	-.8	
4.00 cont A/rel	COUNT	0	0	3	4	0	0	0	4	11
	EXP VAL	.6	1.0	1.9	1.2	1.4	1.6	.3	3.0	11.6%
	ROW PCT	.0%	.0%	27.3%	36.4%	.0%	.0%	.0%	36.4%	
	COL PCT	.0%	.0%	18.8%	40.0%	.0%	.0%	.0%	15.4%	
	TOT PCT	.0%	.0%	3.2%	4.2%	.0%	.0%	.0%	4.2%	
	RESIDUAL	-.6	-1.0	1.1	2.8	-1.4	-1.6	-.3	1.0	
	STD RES	-.8	-1.0	.8	2.6	-1.2	-1.3	-.6	.6	
	ADJ RES	-.8	-1.1	1.0	3.0	-1.3	-1.5	-.6	.7	
10.00	COUNT	2	0	5	4	4	8	1	13	37
	EXP VAL	1.9	3.5	6.2	3.9	4.7	5.5	1.2	10.1	38.9%
	ROW PCT	5.4%	.0%	13.5%	10.8%	10.8%	21.6%	2.7%	35.1%	
	COL PCT	40.0%	.0%	31.3%	40.0%	33.3%	57.1%	33.3%	50.0%	
	TOT PCT	2.1%	.0%	5.3%	4.2%	4.2%	8.4%	1.1%	13.7%	
	RESIDUAL	.1	-3.5	-1.2	.1	-.7	2.5	-.2	2.9	
	STD RES	.0	-1.9	-.5	.1	-.3	1.1	-.2	.9	
	ADJ RES	.0	-2.5	-.7	.1	-.4	1.5	-.2	1.4	
COLUMN TOTAL		5	9	16	10	12	14	3	26	95
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
93.81566	28	0.0000	0.221	36 OF 40 (90.0%)

STATISTIC	VALUE	WITH DEMARCATION SIGNIFICANCE	WITH INSTRUCTION ASSUMPTIONS
CRAMER'S V	0.49687		
CONTINGENCY COEFFICIENT	0.70489		

DEMARCATION BY LEARNING ASSUMPTIONS

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	cognitiv 1.00	behaviou r. 2.00	phenomen 3.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	1	3	2	5	11
	EXP VAL	3.0	1.3	1.9	4.9	11.6%
	ROW PCT	9.1%	27.3%	18.2%	45.5%	
	COL PCT	3.8%	27.3%	12.5%	11.9%	
	TOT PCT	1.1%	3.2%	2.1%	5.3%	
	RESIDUAL	-2.0	1.7	.1	.1	
	STD RES	-1.2	1.5	.1	.1	
	ADJ RES	-1.4	1.7	.1	.1	
2.00 cont B/pragm	COUNT	12	1	3	13	29
	EXP VAL	7.9	3.4	4.9	12.8	30.5%
	ROW PCT	41.4%	3.4%	10.3%	44.8%	
	COL PCT	46.2%	9.1%	18.8%	31.0%	
	TOT PCT	12.6%	1.1%	3.2%	13.7%	
	RESIDUAL	4.1	-2.4	-1.9	.2	
	STD RES	1.4	-1.3	-.9	.0	
	ADJ RES	2.0	-1.6	-1.1	.1	
3.00 undecided rat	COUNT	0	3	2	2	7
	EXP VAL	1.9	.8	1.2	3.1	7.4%
	ROW PCT	.0%	42.9%	28.6%	28.6%	
	COL PCT	.0%	27.3%	12.5%	4.8%	
	TOT PCT	.0%	3.2%	2.1%	2.1%	
	RESIDUAL	-1.9	2.2	.8	-1.1	
	STD RES	-1.4	2.4	.8	-.6	
	ADJ RES	-1.7	2.7	.9	-.9	
4.00 cont A/rel	COUNT	5	2	0	4	11
	EXP VAL	3.0	1.3	1.9	4.9	11.6%
	ROW PCT	45.5%	18.2%	.0%	36.4%	
	COL PCT	19.2%	18.2%	.0%	9.5%	
	TOT PCT	5.3%	2.1%	.0%	4.2%	
	RESIDUAL	2.0	.7	-1.9	-.9	
	STD RES	1.1	.6	-1.4	-.4	
	ADJ RES	1.4	.7	-1.6	-.6	
10.00	COUNT	8	2	9	18	37
	EXP VAL	10.1	4.3	6.2	16.4	38.9%
	ROW PCT	21.6%	5.4%	24.3%	48.6%	
	COL PCT	30.8%	18.2%	56.3%	42.9%	
	TOT PCT	8.4%	2.1%	9.5%	18.9%	
	RESIDUAL	-2.1	-2.3	2.8	1.6	
	STD RES	-.7	-1.1	1.1	.4	
	ADJ RES	-1.0	-1.5	1.6	.7	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
23.74631	12	0.0220	0.811	15 OF 20 (75.0%)

STATISTIC	VALUE	WITH DEMARCATION SIGNIFICANCE	WITH LEARNING ASSUMPTIONS
CRAMER'S V	0.28865		
CONTINGENCY COEFFICIENT	0.44719		

PATTERNS OF CHANGE BY SC. KNOWLEDGE STATUS

PATTERNS OF CHANGE	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	prag-cont b 2.00	indec. rational 3.00	relat-cont a 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	1	5	1	7
	EXP VAL	.5	1.0	3.8	1.6	7.4%
	ROW PCT	.0%	14.3%	71.4%	14.3%	
	COL PCT	.0%	7.1%	9.6%	4.5%	
	TOT PCT	.0%	1.1%	5.3%	1.1%	
	RESIDUAL	-.5	.0	1.2	-.6	
	STD RES	-.7	.0	.6	-.5	
	ADJ RES	-.8	.0	.9	-.6	
3.00 contextualism b	COUNT	1	3	22	8	34
	EXP VAL	2.5	5.0	18.6	7.9	35.8%
	ROW PCT	2.9%	8.8%	64.7%	23.5%	
	COL PCT	14.3%	21.4%	42.3%	36.4%	
	TOT PCT	1.1%	3.2%	23.2%	8.4%	
	RESIDUAL	-1.5	-2.0	3.4	.1	
	STD RES	-1.0	-.9	.8	.0	
	ADJ RES	-1.2	-1.2	1.5	.1	
4.00 contextualism a	COUNT	1	7	7	2	17
	EXP VAL	1.3	2.5	9.3	3.9	17.9%
	ROW PCT	5.9%	41.2%	41.2%	11.8%	
	COL PCT	14.3%	50.0%	13.5%	9.1%	
	TOT PCT	1.1%	7.4%	7.4%	2.1%	
	RESIDUAL	-.3	4.5	-2.3	-1.9	
	STD RES	-.2	2.8	-.8	-1.0	
	ADJ RES	-.3	3.4	-1.2	-1.2	
5.00 relativism	COUNT	0	0	4	0	4
	EXP VAL	.3	.6	2.2	.9	4.2%
	ROW PCT	.0%	.0%	100.0%	.0%	
	COL PCT	.0%	.0%	7.7%	.0%	
	TOT PCT	.0%	.0%	4.2%	.0%	
	RESIDUAL	-.3	-.6	1.8	-.9	
	STD RES	-.5	-.8	1.2	-1.0	
	ADJ RES	-.6	-.8	1.9	-1.1	
10.00 eclectic	COUNT	5	3	14	10	32
	EXP VAL	2.4	4.7	17.5	7.4	33.7%
	ROW PCT	15.6%	9.4%	43.8%	31.3%	
	COL PCT	71.4%	21.4%	26.9%	45.5%	
	TOT PCT	5.3%	3.2%	14.7%	10.5%	
	RESIDUAL	2.6	-1.7	-3.5	2.6	
	STD RES	1.7	-.8	-.8	1.0	
	ADJ RES	2.2	-1.1	-1.5	1.3	
11.00 missing answers	COUNT	0	0	0	1	1
	EXP VAL	.1	.1	.5	.2	1.1%
	ROW PCT	.0%	.0%	.0%	100.0%	
	COL PCT	.0%	.0%	.0%	4.5%	
	TOT PCT	.0%	.0%	.0%	1.1%	
	RESIDUAL	-.1	-.1	-.5	.8	
	STD RES	-.3	-.4	-.7	1.6	
	ADJ RES	-.3	-.4	-1.1	1.8	
COLUMN TOTAL		7	14	52	22	95
		7.4%	14.7%	54.7%	23.2%	100.0%

CHI-SQUARE D.F. SIGNIFICANCE MIN E.F. CELLS WITH E.F.< 5

DEMARCATION BY CLASSROOM ACTIVITIES

DEMARCATION	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher achi... 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
1.00 "truth"	COUNT	7	2	1	1	0	11
	EXP VAL	5.2	3.0	.8	1.7	.2	11.6%
	ROW PCT	63.6%	18.2%	9.1%	9.1%	.0%	
	COL PCT	15.6%	7.7%	14.3%	6.7%	.0%	
	TOT PCT	7.4%	2.1%	1.1%	1.1%	.0%	
	RESIDUAL	1.8	-1.0	.2	-.7	-.2	
	STD RES	.8	-.6	.2	-.6	-.5	
	ADJ RES	1.1	-.7	.2	-.6	-.5	
2.00 cont B/pragm	COUNT	16	10	2	1	0	29
	EXP VAL	13.7	7.9	2.1	4.6	.6	30.5%
	ROW PCT	55.2%	34.5%	6.9%	3.4%	.0%	
	COL PCT	35.6%	38.5%	28.6%	6.7%	.0%	
	TOT PCT	16.8%	10.5%	2.1%	1.1%	.0%	
	RESIDUAL	2.3	2.1	-.1	-3.6	-.6	
	STD RES	.6	.7	-.1	-1.7	-.8	
	ADJ RES	1.0	1.0	-.1	-2.2	-.9	
3.00 undecided rat	COUNT	4	3	0	0	0	7
	EXP VAL	3.3	1.9	.5	1.1	.1	7.4%
	ROW PCT	57.1%	42.9%	.0%	.0%	.0%	
	COL PCT	8.9%	11.5%	.0%	.0%	.0%	
	TOT PCT	4.2%	3.2%	.0%	.0%	.0%	
	RESIDUAL	.7	1.1	-.5	-1.1	-.1	
	STD RES	.4	.8	-.7	-1.1	-.4	
	ADJ RES	.5	1.0	-.8	-1.2	-.4	
4.00 cont A/rel	COUNT	3	3	1	4	0	11
	EXP VAL	5.2	3.0	.8	1.7	.2	11.6%
	ROW PCT	27.3%	27.3%	9.1%	36.4%	.0%	
	COL PCT	6.7%	11.5%	14.3%	26.7%	.0%	
	TOT PCT	3.2%	3.2%	1.1%	4.2%	.0%	
	RESIDUAL	-2.2	.0	.2	2.3	-.2	
	STD RES	-1.0	.0	.2	1.7	-.5	
	ADJ RES	-1.4	.0	.2	2.0	-.5	
10.00	COUNT	15	8	3	9	2	37
	EXP VAL	17.5	10.1	2.7	5.8	.8	38.9%
	ROW PCT	40.5%	21.6%	8.1%	24.3%	5.4%	
	COL PCT	33.3%	30.8%	42.9%	60.0%	100.0%	
	TOT PCT	15.8%	8.4%	3.2%	9.5%	2.1%	
	RESIDUAL	-2.5	-2.1	.3	3.2	1.2	
	STD RES	-.6	-.7	.2	1.3	1.4	
	ADJ RES	-1.1	-1.0	.2	1.8	1.8	
COLUMN TOTAL		45	26	7	15	2	95
		47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
17.01306	16	0.3848	0.147	18 OF 25 (72.0%)

WITH DEMARCATION WITH CLASSROOM ACTIVITIES

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.21159	
CONTINGENCY COEFFICIENT	0.38972	

CROSSTABULATION OF PATTERNS OF CHANGE BY INTEGRATION

PATTERNS OF CHANGE	INTEGRATION	sep-cont I-prac 1.00	sep-else 2.00	int-c-m-sr 3.00	int-prac 4.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	0	4	1	2	7
	EXP VAL	1.7	.6	2.5	1.4	.8	7.4%
	ROW PCT	.0%	.0%	57.1%	14.3%	28.6%	
	COL PCT	.0%	.0%	11.8%	5.3%	18.2%	
	TOT PCT	.0%	.0%	4.2%	1.1%	2.1%	
	RESIDUAL	-1.7	-.6	1.5	-.4	1.2	
	STD RES	-1.3	-.8	.9	-.3	1.3	
	ADJ RES	-1.6	-.8	1.2	-.4	1.5	
3.00 contextualism B	COUNT	4	7	16	6	1	34
	EXP VAL	8.2	2.9	12.2	6.8	3.9	35.8%
	ROW PCT	11.8%	20.6%	47.1%	17.6%	2.9%	
	COL PCT	17.4%	87.5%	47.1%	31.6%	9.1%	
	TOT PCT	4.2%	7.4%	16.8%	6.3%	1.1%	
	RESIDUAL	-4.2	4.1	3.8	-.8	-2.9	
	STD RES	-1.5	2.4	1.1	-.3	-1.5	
	ADJ RES	-2.1	3.2	1.7	-.4	-2.0	
4.00 contextualism A	COUNT	6	0	4	6	1	17
	EXP VAL	4.1	1.4	6.1	3.4	2.0	17.9%
	ROW PCT	35.3%	.0%	23.5%	35.3%	5.9%	
	COL PCT	26.1%	.0%	11.8%	31.6%	9.1%	
	TOT PCT	6.3%	.0%	4.2%	6.3%	1.1%	
	RESIDUAL	1.9	-1.4	-2.1	2.6	-1.0	
	STD RES	.9	-1.2	-.8	1.4	-.7	
	ADJ RES	1.2	-1.4	-1.2	1.7	-.8	
5.00 relativism	COUNT	0	0	0	0	4	4
	EXP VAL	1.0	.3	1.4	.8	.5	4.2%
	ROW PCT	.0%	.0%	.0%	.0%	100.0%	
	COL PCT	.0%	.0%	.0%	.0%	36.4%	
	TOT PCT	.0%	.0%	.0%	.0%	4.2%	
	RESIDUAL	-1.0	-.3	-1.4	-.8	3.5	
	STD RES	-1.0	-.6	-1.2	-.9	5.2	
	ADJ RES	-1.2	-.6	-1.5	-1.0	5.6	
10.00 eclectic	COUNT	13	1	9	6	3	32
	EXP VAL	7.7	2.7	11.5	6.4	3.7	33.7%
	ROW PCT	40.6%	3.1%	28.1%	18.8%	9.4%	
	COL PCT	56.5%	12.5%	26.5%	31.6%	27.3%	
	TOT PCT	13.7%	1.1%	9.5%	6.3%	3.2%	
	RESIDUAL	5.3	-1.7	-2.5	-.4	-.7	
	STD RES	1.9	-1.0	-.7	-.2	-.4	
	ADJ RES	2.7	-1.3	-1.1	-.2	-.5	
11.00 missing answers	COUNT	0	0	1	0	0	1
	EXP VAL	.2	.1	.4	.2	.1	1.1%
	ROW PCT	.0%	.0%	100.0%	.0%	.0%	
	COL PCT	.0%	.0%	2.9%	.0%	.0%	
	TOT PCT	.0%	.0%	1.1%	.0%	.0%	
	RESIDUAL	-.2	-.1	.6	-.2	-.1	
	STD RES	-.5	-.3	1.1	-.4	-.3	
	ADJ RES	-.6	-.3	1.3	-.5	-.4	
COLUMN TOTAL		23	8	34	19	11	95
		24.2%	8.4%	35.8%	20.0%	11.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
59.80370	20	0.0000	0.084	23 OF 30 (76.7%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.37671	
CONTINGENCY COEFFICIENT	0.62155	

WITH PATTERNS OF CHANGE WITH INTEGRATION

CROSSTABULATION OF PATTERNS OF CHANGE BY ISSUE OF REALITY

PATTERNS OF CHANGE	ISSUE OF REALITY	pragmaticism 2.00	rc. realism 3.00	idealism 4.00	scepticism 5.00	eclectic 10.00	ROW TOTAL
1.00 inductivism	COUNT	0	3	1	0	3	7
	EXP VAL	.1	2.8	1.5	.2	2.4	7.4%
	ROW PCT	.0%	42.9%	14.3%	.0%	42.9%	
	COL PCT	.0%	7.9%	4.8%	.0%	9.4%	
	TOT PCT	.0%	3.2%	1.1%	.0%	3.2%	
	RESIDUAL	-.1	.2	-.5	-.2	.6	
	STD RES	-.3	.1	-.4	-.5	.4	
	ADJ RES	-.3	.2	-.5	-.5	.5	
3.00 contextualism b	COUNT	0	11	11	1	11	34
	EXP VAL	.4	13.6	7.5	1.1	11.5	35.8%
	ROW PCT	.0%	32.4%	32.4%	2.9%	32.4%	
	COL PCT	.0%	28.9%	52.4%	33.3%	34.4%	
	TOT PCT	.0%	11.6%	11.6%	1.1%	11.6%	
	RESIDUAL	-.4	-2.6	3.5	-.1	-.5	
	STD RES	-.6	-.7	1.3	-.1	-.1	
	ADJ RES	-.8	-1.1	1.8	-.1	-.2	
4.00 contextualism a	COUNT	1	9	1	2	4	17
	EXP VAL	.2	6.8	3.8	.5	5.7	17.9%
	ROW PCT	5.9%	52.9%	5.9%	11.8%	23.5%	
	COL PCT	100.0%	23.7%	4.8%	66.7%	12.5%	
	TOT PCT	1.1%	9.5%	1.1%	2.1%	4.2%	
	RESIDUAL	.8	2.2	-2.8	1.5	-1.7	
	STD RES	1.9	.8	-1.4	2.0	-.7	
	ADJ RES	2.2	1.2	-1.8	2.2	-1.0	
5.00 relativism	COUNT	0	0	0	0	4	4
	EXP VAL	.0	1.6	.9	.1	1.3	4.2%
	ROW PCT	.0%	.0%	.0%	.0%	100.0%	
	COL PCT	.0%	.0%	.0%	.0%	12.5%	
	TOT PCT	.0%	.0%	.0%	.0%	4.2%	
	RESIDUAL	.0	-1.6	-.9	-.1	2.7	
	STD RES	-.2	-1.3	-.9	-.4	2.3	
	ADJ RES	-.2	-1.7	-1.1	-.4	2.9	
10.00 eclectic	COUNT	0	15	8	0	9	32
	EXP VAL	.3	12.8	7.1	1.0	10.8	33.7%
	ROW PCT	.0%	46.9%	25.0%	.0%	28.1%	
	COL PCT	.0%	39.5%	38.1%	.0%	28.1%	
	TOT PCT	.0%	15.8%	8.4%	.0%	9.5%	
	RESIDUAL	-.3	2.2	.9	-1.0	-1.8	
	STD RES	-.6	.6	.3	-1.0	-.5	
	ADJ RES	-.7	1.0	.5	-1.3	-.8	
11.00 missing answers	COUNT	0	0	0	0	1	1
	EXP VAL	.0	.4	.2	.0	.3	1.1%
	ROW PCT	.0%	.0%	.0%	.0%	100.0%	
	COL PCT	.0%	.0%	.0%	.0%	3.1%	
	TOT PCT	.0%	.0%	.0%	.0%	1.1%	
	RESIDUAL	.0	-.4	-.2	.0	.7	
	STD RES	-.1	-.6	-.5	-.2	1.1	
	ADJ RES	-.1	-.8	-.5	-.2	1.4	
COLUMN TOTAL		1	38	21	3	32	95
		1.1%	40.0%	22.1%	3.2%	33.7%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
26.16598	20	0.1604	0.011	22 OF 30 (73.3%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.26241	
CONTINGENCY COEFFICIENT	0.46471	

WITH PATTERNS OF CHANGE WITH ISSUE OF REA.

C R O S S T A B U L A T I O N O F

PATTERNS OF CHANGE BY "CONTENT" AND "PROCES

"CONTENT" AND "PROCESS"

PATTERNS OF CHANGE	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rel.-law ls-exp 1.00	rel-fact s-meth 2.00	rel-fact s-exp 3.00	dist-fac ts-exp 4.00	dist-fac ts-meth 5.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	2	5	0	0	0	7
	EXP VAL	.3	1.5	3.1	.5	.7	.9	7.4%
	ROW PCT	.0%	28.6%	71.4%	.0%	.0%	.0%	
	COL PCT	.0%	10.0%	11.9%	.0%	.0%	.0%	
	TOT PCT	.0%	2.1%	5.3%	.0%	.0%	.0%	
	RESIDUAL	-.3	.5	1.9	-.5	-.7	-.9	
	STD RES	-.5	.4	1.1	-.7	-.9	-.9	
	ADJ RES	-.6	.5	1.5	-.8	-.9	-1.0	
3.00 contextualism B	COUNT	0	8	20	3	0	3	34
	EXP VAL	1.4	7.2	15.0	2.5	3.6	4.3	35.8%
	ROW PCT	.0%	23.5%	58.8%	8.8%	.0%	8.8%	
	COL PCT	.0%	40.0%	47.6%	42.9%	.0%	25.0%	
	TOT PCT	.0%	8.4%	21.1%	3.2%	.0%	3.2%	
	RESIDUAL	-1.4	.8	5.0	.5	-3.6	-1.3	
	STD RES	-1.2	.3	1.3	.3	-1.9	-.6	
	ADJ RES	-1.5	.4	2.1	.4	-2.5	-.8	
4.00 contextualism A	COUNT	4	3	2	3	4	1	17
	EXP VAL	.7	3.6	7.5	1.3	1.8	2.1	17.9%
	ROW PCT	23.5%	17.6%	11.8%	17.6%	23.5%	5.9%	
	COL PCT	100.0%	15.0%	4.8%	42.9%	40.0%	8.3%	
	TOT PCT	4.2%	3.2%	2.1%	3.2%	4.2%	1.1%	
	RESIDUAL	3.3	-.6	-5.5	1.7	2.2	-1.1	
	STD RES	3.9	-.3	-2.0	1.6	1.7	-.8	
	ADJ RES	4.4	-.4	-3.0	1.8	1.9	-.9	
5.00 relativism	COUNT	0	1	3	0	0	0	4
	EXP VAL	.2	.8	1.8	.3	.4	.5	4.2%
	ROW PCT	.0%	25.0%	75.0%	.0%	.0%	.0%	
	COL PCT	.0%	5.0%	7.1%	.0%	.0%	.0%	
	TOT PCT	.0%	1.1%	3.2%	.0%	.0%	.0%	
	RESIDUAL	-.2	.2	1.2	-.3	-.4	-.5	
	STD RES	-.4	.2	.9	-.5	-.6	-.7	
	ADJ RES	-.4	.2	1.3	-.6	-.7	-.8	
10.00 eclectic	COUNT	0	5	12	1	6	8	32
	EXP VAL	1.3	6.7	14.1	2.4	3.4	4.0	33.7%
	ROW PCT	.0%	15.6%	37.5%	3.1%	18.8%	25.0%	
	COL PCT	.0%	25.0%	28.6%	14.3%	60.0%	66.7%	
	TOT PCT	.0%	5.3%	12.6%	1.1%	6.3%	8.4%	
	RESIDUAL	-1.3	-1.7	-2.1	-1.4	2.6	4.0	
	STD RES	-1.2	-.7	-.6	-.9	1.4	2.0	
	ADJ RES	-1.5	-.9	-.9	-1.1	1.9	2.6	
11.00 missing answers	COUNT	0	1	0	0	0	0	1
	EXP VAL	.0	.2	.4	.1	.1	.1	1.1%
	ROW PCT	.0%	100.0%	.0%	.0%	.0%	.0%	
	COL PCT	.0%	5.0%	.0%	.0%	.0%	.0%	
	TOT PCT	.0%	1.1%	.0%	.0%	.0%	.0%	
	RESIDUAL	.0	.8	-.4	-.1	-.1	-.1	
	STD RES	-.2	1.7	-.7	-.3	-.3	-.4	
	ADJ RES	-.2	1.9	-.9	-.3	-.3	-.4	
COLUMN TOTAL		4	20	42	7	10	12	95
		4.2%	21.1%	44.2%	7.4%	10.5%	12.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
50.88519	25	0.0017	0.042	31 OF 36 (86.1%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.32730	
CONTINGENCY COEFFICIENT	0.59060	

WITH PATTERNS OF CHANGE WITH "CONTENT" AND

C R O S S T A B U L A T I O N O F

PATTERNS OF CHANGE BY LEARNING ASSUMPTION

LEARNING ASSUMPTIO[illegible]

PATTERNS OF CHANGE	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	cognitiv e 1.00	behav.ou r [illegible]	phenomen . 3.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	1	[illegible]	1	3	7
	EXP VAL	1.9	.8	1.2	3.1	7.4%
	ROW PCT	14.3%	[illegible]	14.3%	[illegible]	
	COL PCT	3.8%	18.2%	6.3%	7.1%	
	TOT PCT	1.1%	2.1%	1.1%	3.2%	
	RESIDUAL	-.9	1.2	-.2	-.1	
	STD RES	-.7	1.3	-.2	-.1	
	ADJ RES	-.8	1.5	-.2	-.1	
3.00 contextualism B	COUNT	14	4	0	16	34
	EXP VAL	9.3	3.9	5.7	15.0	35.8%
	ROW PCT	41.2%	11.8%	.0%	47.1%	
	COL PCT	53.8%	36.4%	.0%	38.1%	
	TOT PCT	14.7%	4.2%	.0%	16.8%	
	RESIDUAL	4.7	.1	-5.7	1.0	
	STD RES	1.5	.0	-2.4	.2	
	ADJ RES	2.3	.0	-3.3	.4	
4.00 contextualism A	COUNT	3	2	5	7	17
	EXP VAL	4.7	2.0	2.9	7.5	17.9%
	ROW PCT	17.6%	11.8%	29.4%	41.2%	
	COL PCT	11.5%	18.2%	31.3%	16.7%	
	TOT PCT	3.2%	2.1%	5.3%	7.4%	
	RESIDUAL	-1.7	.0	2.1	-.5	
	STD RES	-.8	.0	1.3	-.2	
	ADJ RES	-1.0	.0	1.5	-.3	
5.00 relativism	COUNT	3	0	0	1	4
	EXP VAL	1.1	.5	.7	1.8	4.2%
	ROW PCT	75.0%	.0%	.0%	25.0%	
	COL PCT	11.5%	.0%	.0%	2.4%	
	TOT PCT	3.2%	.0%	.0%	1.1%	
	RESIDUAL	1.9	-.5	-.7	-.8	
	STD RES	1.8	-.7	-.8	-.6	
	ADJ RES	2.2	-.7	-.9	-.8	
10.00 eclectic	COUNT	5	3	9	15	32
	EXP VAL	8.8	3.7	5.4	14.1	33.7%
	ROW PCT	15.6%	9.4%	28.1%	46.9%	
	COL PCT	19.2%	27.3%	56.3%	35.7%	
	TOT PCT	5.3%	3.2%	9.5%	15.8%	
	RESIDUAL	-3.8	-.7	3.6	.9	
	STD RES	-1.3	-.4	1.6	.2	
	ADJ RES	-1.8	-.5	2.1	.4	
11.00 missing answers	COUNT	0	0	1	0	1
	EXP VAL	.3	.1	.2	.4	1.1%
	ROW PCT	.0%	.0%	100.0%	.0%	
	COL PCT	.0%	.0%	6.3%	.0%	
	TOT PCT	.0%	.0%	1.1%	.0%	
	RESIDUAL	-.3	-.1	.8	-.4	
	STD RES	-.5	-.3	2.0	-.7	
	ADJ RES	-.6	-.4	2.2	-.9	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
26.53044	15	0.0328	0.116	17 OF 24 (70.8%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.30511	
CONTINGENCY COEFFICIENT	0.46723	

WITH PATTERNS OF CHANGE WITH LEARNING AS[illegible]

PATTERNS OF CHANGE BY INSTRUCTION ASSUMPTI[ONS]

INSTRUCTION ASSUMPTIONS

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

PATTERNS OF CHANGE		tech.sw. occ.part 1.00	bal.sm.i nteg.pa 2.00	bal.sm.o cc.part 3.00	bal.sm.i nteg.emo 4.00	bal.sm.o cc.emot 5.00	bal.id.o cc.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
1.00 inductivism	COUNT	0	0	2	0	0	1	0	4	[illegible]
	EXP VAL	[illegible]	.7	1.[illegible]	.7	.9	1.0	.2	1.9	
	ROW PCT	.0%	.0%	28.6%	.0%	.0%	14.3%	.0%	57.1%	
	COL PCT	.0%	.0%	12.5%	.0%	.0%	7.1%	.0%	15.4%	
	TOT PCT	.0%	.0%	2.1%	.0%	.0%	1.1%	.0%	4.2%	
	RESIDUAL	-.4	-.7	.8	-.7	-.9	.0	-.2	2.1	
	STD RES	-.6	-.8	.8	-.9	-.9	.0	-.5	1.5	
	ADJ RES	-.6	-.9	.9	-.9	-1.0	.0	-.5	1.8	
3.00 contextualism B	COUNT	4	2	8	8	2	3	1	6	35.
	EXP VAL	1.8	3.2	5.7	3.6	4.3	5.0	1.1	9.3	
	ROW PCT	11.8%	5.9%	23.5%	23.5%	5.9%	8.8%	2.9%	17.6%	
	COL PCT	80.0%	22.2%	50.0%	80.0%	16.7%	21.4%	33.3%	23.1%	
	TOT PCT	4.2%	2.1%	8.4%	8.4%	2.1%	3.2%	1.1%	6.3%	
	RESIDUAL	2.2	-1.2	2.3	4.4	-2.3	-2.0	-.1	-3.3	
	STD RES	1.7	-.7	1.0	2.3	-1.1	-.9	-.1	-1.1	
	ADJ RES	2.1	-.9	1.3	3.1	-1.5	-1.2	-.1	-1.6	
4.00 contextualism A	COUNT	0	4	0	0	5	5	0	3	17.
	EXP VAL	.9	1.6	2.9	1.8	2.1	2.5	.5	4.7	
	ROW PCT	.0%	23.5%	.0%	.0%	29.4%	29.4%	.0%	17.6%	
	COL PCT	.0%	44.4%	.0%	.0%	41.7%	35.7%	.0%	11.5%	
	TOT PCT	.0%	4.2%	.0%	.0%	5.3%	5.3%	.0%	3.2%	
	RESIDUAL	-.9	2.4	-2.9	-1.8	2.9	2.5	-.5	-1.7	
	STD RES	-.9	1.9	-1.7	-1.3	1.9	1.6	-.7	-.8	
	ADJ RES	-1.1	2.2	-2.0	-1.6	2.3	1.9	-.8	-1.0	
5.00 relativism	COUNT	1	0	3	0	0	0	0	0	4.
	EXP VAL	.2	.4	.7	.4	.5	.6	.1	1.1	
	ROW PCT	25.0%	.0%	75.0%	.0%	.0%	.0%	.0%	.0%	
	COL PCT	20.0%	.0%	18.8%	.0%	.0%	.0%	.0%	.0%	
	TOT PCT	1.1%	.0%	3.2%	.0%	.0%	.0%	.0%	.0%	
	RESIDUAL	.8	-.4	2.3	-.4	-.5	-.6	-.1	-1.1	
	STD RES	1.7	-.6	2.8	-.6	-.7	-.8	-.4	-1.0	
	ADJ RES	1.8	-.7	3.2	-.7	-.8	-.8	-.4	-1.3	
10.00 eclectic	COUNT	0	3	2	2	5	5	2	13	33.
	EXP VAL	1.7	3.0	5.4	3.4	4.0	4.7	1.0	8.8	
	ROW PCT	.0%	9.4%	6.3%	6.3%	15.6%	15.6%	6.3%	40.6%	
	COL PCT	.0%	33.3%	12.5%	20.0%	41.7%	35.7%	66.7%	50.0%	
	TOT PCT	.0%	3.2%	2.1%	2.1%	5.3%	5.3%	2.1%	13.7%	
	RESIDUAL	-1.7	.0	-3.4	-1.4	1.0	.3	1.0	4.2	
	STD RES	-1.3	.0	-1.5	-.7	.5	.1	1.0	1.4	
	ADJ RES	-1.6	.0	-2.0	-1.0	.6	.2	1.2	2.1	
11.00 missing answers	COUNT	0	0	1	0	0	0	0	0	1.
	EXP VAL	.1	.1	.2	.1	.1	.1	.0	.3	
	ROW PCT	.0%	.0%	100.0%	.0%	.0%	.0%	.0%	.0%	
	COL PCT	.0%	.0%	6.3%	.0%	.0%	.0%	.0%	.0%	
	TOT PCT	.0%	.0%	1.1%	.0%	.0%	.0%	.0%	.0%	
	RESIDUAL	-.1	-.1	.8	-.1	-.1	-.1	.0	-.3	
	STD RES	-.2	-.3	2.0	-.3	-.4	-.4	-.2	-.5	
	ADJ RES	-.2	-.3	2.2	-.3	-.4	-.4	-.2	-.6	
COLUMN TOTAL		5	9	16	10	12	14	3	26	9
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
61.66039	35	0.0036	0.032	43 OF 48 (89.6%)

STATISTIC	VALUE	WITH PATTERNS OF CHANGE SIGNIFICANCE	WITH INSTRUCTION A
CRAMER'S V	0.34029		
CONTINGENCY COEFFICIENT	0.62737		

PATTERNS OF CHANGE BY CLASSROOM ACTIVITIES

CLASSROOM ACTIVITIES

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

PATTERNS OF CHANGE		teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	1[illegible].00	ROW TOTAL
1.00 inductivism	COUNT	3	3	1	0	0	7
	EXP VAL	3.3	1.9	.5	1.1	.1	7.4%
	ROW PCT	42.9%	42.9%	14.3%	[illegible]	.0%	
	COL PCT	6.7%	11.5%	14.3%	.0%	.0%	
	TOT PCT	3.2%	3.2%	1.1%	.0%	.0%	
	RESIDUAL	-.3	1.1	.5	-1.1	-.1	
	STD RES	-.2	.8	.7	-1.1	-.4	
	ADJ RES	-.2	1.0	.7	-1.2	-.4	
3.00 contextualism B	COUNT	18	10	1	3	2	34
	EXP VAL	16.1	9.3	2.5	5.4	.7	35.8%
	ROW PCT	52.9%	29.4%	2.9%	8.8%	5.9%	
	COL PCT	40.0%	38.5%	14.3%	20.0%	100.0%	
	TOT PCT	18.9%	10.5%	1.1%	3.2%	2.1%	
	RESIDUAL	1.9	.7	-1.5	-2.4	1.3	
	STD RES	.5	.2	-1.0	-1.0	1.5	
	ADJ RES	.8	.3	-1.2	-1.4	1.9	
4.00 contextualism A	COUNT	7	4	4	2	0	17
	EXP VAL	8.1	4.7	1.3	2.7	.4	17.9%
	ROW PCT	41.2%	23.5%	23.5%	11.8%	.0%	
	COL PCT	15.6%	15.4%	57.1%	13.3%	.0%	
	TOT PCT	7.4%	4.2%	4.2%	2.1%	.0%	
	RESIDUAL	-1.1	-.7	2.7	-.7	-.4	
	STD RES	-.4	-.3	2.5	-.4	-.6	
	ADJ RES	-.6	-.4	2.8	-.5	-.7	
5.00 relativism	COUNT	1	3	0	0	0	4
	EXP VAL	1.9	1.1	.3	.6	.1	4.2%
	ROW PCT	25.0%	75.0%	.0%	.0%	.0%	
	COL PCT	2.2%	11.5%	.0%	.0%	.0%	
	TOT PCT	1.1%	3.2%	.0%	.0%	.0%	
	RESIDUAL	-.9	1.9	-.3	-.6	-.1	
	STD RES	-.7	1.8	-.5	-.8	-.3	
	ADJ RES	-.9	2.2	-.6	-.9	-.3	
10.00 eclectic	COUNT	16	6	1	9	0	32
	EXP VAL	15.2	8.8	2.4	5.1	.7	33.7%
	ROW PCT	50.0%	18.8%	3.1%	28.1%	.0%	
	COL PCT	35.6%	23.1%	14.3%	60.0%	.0%	
	TOT PCT	16.8%	6.3%	1.1%	9.5%	.0%	
	RESIDUAL	.8	-2.8	-1.4	3.9	-.7	
	STD RES	.2	-.9	-.9	1.8	-.8	
	ADJ RES	.4	-1.3	-1.1	2.3	-1.0	
11.00 missing answers	COUNT	0	0	0	1	0	1
	EXP VAL	.5	.3	.1	.2	.0	1.1%
	ROW PCT	.0%	.0%	.0%	100.0%	.0%	
	COL PCT	.0%	.0%	.0%	6.7%	.0%	
	TOT PCT	.0%	.0%	.0%	1.1%	.0%	
	RESIDUAL	-.5	-.3	-.1	.8	.0	
	STD RES	-.7	-.5	-.3	2.1	-.1	
	ADJ RES	-1.0	-.6	-.3	2.3	-.1	
COLUMN TOTAL		45	26	7	15	2	95
		47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
29.20326	2[illegible]	0.0838	[illegible].021	[illegible] OF 30 (76.7%)

STATISTIC	VALUE	WITH PATTERNS OF CHANGE SIGNIFICANCE	WITH CLASSROOM AC
CRAMER'S V	0.27722		
CONTINGENCY COEFFICIENT	0.48490		

SC. KNOWLEDGE STATUS BY "CONTENT" AND "PROC

"CONTENT" AND "PROCESS"

SC. KNOWLEDGE STATUS	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rel.-law ts-exp 1.00	rel-fact s-meth 2.00	rel-fact s-exp 3.00	dist-fac ts-exp 4.00	dist-fac ts-meth 5.00	10.00	ROW TOTAL
2.00 prag-cont F	COUNT	0	0	3	0	3	1	7
	EXP VAL	.3	1.5	3.1	.5	.7	.9	7.4%
	ROW PCT	.0%	.0%	42.9%	.0%	42.9%	14.3%	
	COL PCT	.0%	.0%	7.1%	.0%	30.0%	8.3%	
	TOT PCT	.0%	.0%	3.2%	.0%	3.2%	1.1%	
	RESIDUAL	-.3	-1.5	-.1	-.5	2.3	.1	
	STD RES	-.5	-1.2	-.1	-.7	2.6	.1	
	ADJ RES	-.6	-1.4	-.1	-.8	2.9	.1	
3.00 undec. rational	COUNT	0	2	1	3	5	3	14
	EXP VAL	.6	2.9	6.2	1.0	1.5	1.8	14.7%
	ROW PCT	.0%	14.3%	7.1%	21.4%	35.7%	21.4%	
	COL PCT	.0%	10.0%	2.4%	42.9%	50.0%	25.0%	
	TOT PCT	.0%	2.1%	1.1%	3.2%	5.3%	3.2%	
	RESIDUAL	-.6	-.9	-5.2	2.0	3.5	1.2	
	STD RES	-.8	-.6	-2.1	1.9	2.9	.9	
	ADJ RES	-.8	-.7	-3.0	2.2	3.3	1.1	
4.00 relat-cont A	COUNT	4	16	28	1	0	3	52
	EXP VAL	2.2	10.9	23.0	3.8	5.5	6.6	54.7%
	ROW PCT	7.7%	30.8%	53.8%	1.9%	.0%	5.8%	
	COL PCT	100.0%	80.0%	66.7%	14.3%	.0%	25.0%	
	TOT PCT	4.2%	16.8%	29.5%	1.1%	.0%	3.2%	
	RESIDUAL	1.8	5.1	5.0	-2.8	-5.5	-3.6	
	STD RES	1.2	1.5	1.0	-1.4	-2.3	-1.4	
	ADJ RES	1.9	2.6	2.1	-2.2	-3.7	-2.2	
10.00	COUNT	0	2	10	3	2	5	22
	EXP VAL	.9	4.6	9.7	1.6	2.3	2.8	23.2%
	ROW PCT	.0%	9.1%	45.5%	13.6%	9.1%	22.7%	
	COL PCT	.0%	10.0%	23.8%	42.9%	20.0%	41.7%	
	TOT PCT	.0%	2.1%	10.5%	3.2%	2.1%	5.3%	
	RESIDUAL	-.9	-2.6	.3	1.4	-.3	2.2	
	STD RES	-1.0	-1.2	.1	1.1	-.2	1.3	
	ADJ RES	[illegible]	-1.6	.1	1.3	-.3	1.6	
COLUMN TOTAL		[illegible]	20	42	7	10	12	95
		[illegible]	21.1%	44.2%	7.4%	10.5%	12.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
47.39668	15	0.0000	0.295	18 OF 24 (75.0%)

STATISTIC	VALUE	SIGNIFICANCE
		WITH SC. KNOWLEDGE STATUS WITH "CONTENT" AN
CRAMER'S V	0.40780	
CONTINGENCY COEFFICIENT	0.57693	

SC. KNOWLEDGE STATUS BY ISSUE OF REALITY

ISSUE OF REALITY

SC. KNOWLEDGE STATUS	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	pragmatism 2.00	sc. realism 3.00	idealism 4.00	scepticism 5.00	eclectic 10.00	ROW TOTAL
2.00 prag-cont 1	COUNT	0	1	2	0	4	7
	EXP VAL	.1	2.8	1.5	.2	2.4	7.4%
	ROW PCT	.0%	14.3%	28.6%	.0%	57.1%	
	COL PCT	.0%	2.6%	9.5%	.0%	12.5%	
	TOT PCT	.0%	1.1%	2.1%	.0%	4.2%	
	RESIDUAL	-.1	-1.8	.5	-.2	1.6	
	STD RES	-.3	-1.1	.4	-.5	1.1	
	ADJ RES	-.3	-1.4	.4	-.5	1.4	
3.00 undec. rational	COUNT	0	9	4	0	1	14
	EXP VAL	.1	5.6	3.1	.4	4.7	14.7%
	ROW PCT	.0%	64.3%	28.6%	.0%	7.1%	
	COL PCT	.0%	23.7%	19.0%	.0%	3.1%	
	TOT PCT	.0%	9.5%	4.2%	.0%	1.1%	
	RESIDUAL	-.1	3.4	.9	-.4	-3.7	
	STD RES	-.4	1.4	.5	-.7	-1.7	
	ADJ RES	-.4	2.0	.6	-.7	-2.3	
4.00 relat-cont A	COUNT	0	18	10	3	21	52
	EXP VAL	.5	20.8	11.5	1.6	17.5	54.7%
	ROW PCT	.0%	34.6%	19.2%	5.8%	40.4%	
	COL PCT	.0%	47.4%	47.6%	100.0%	65.6%	
	TOT PCT	.0%	18.9%	10.5%	3.2%	22.1%	
	RESIDUAL	-.5	-2.8	-1.5	1.4	3.5	
	STD RES	-.7	-.6	-.4	1.1	.8	
	ADJ RES	-1.1	-1.2	-.7	1.6	1.5	
10.00	COUNT	1	10	5	0	6	22
	EXP VAL	.2	8.8	4.9	.7	7.4	23.2%
	ROW PCT	4.5%	45.5%	22.7%	.0%	27.3%	
	COL PCT	100.0%	26.3%	23.8%	.0%	18.8%	
	TOT PCT	1.1%	10.5%	5.3%	.0%	6.3%	
	RESIDUAL	.8	1.2	.1	-.7	-1.4	
	STD RES	1.6	.4	.1	-.8	-.5	
	ADJ RES	1.8	.6	.1	-1.0	-.7	
COLUMN TOTAL		1	38	21	3	32	95
		1.1%	40.0%	22.1%	3.2%	33.7%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
15.18937	12	0.2312	0.074	14 OF 20 (70.0%)

STATISTIC	VALUE	SIGNIFICANCE
		WITH SC. KNOWLEDGE STATUS WITH ISSUE OF RE
CRAMER'S V	0.23086	
CONTINGENCY COEFFICIENT	0.37128	

CROSSTABULATION OF SC. KNOWLEDGE STATUS BY LEARNING ASSUMPTIONS

SC. KNOWLEDGE STATUS — LEARNING ASSUMPTIONS

Cell contents: COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

SC. KNOWLEDGE STATUS		cognit.behavior 1.00	behaviour 2.00	phenomen. 3.00	10.00	ROW TOTAL
2.00 prag-cont B	COUNT	0	4	0	3	7
	EXP VAL	1.9	.8	1.2	3.1	7.4%
	ROW PCT	.0%	57.1%	.0%	42.9%	
	COL PCT	.0%	36.4%	.0%	7.1%	
	TOT PCT	.0%	4.2%	.0%	3.2%	
	RESIDUAL	-1.9	3.2	-1.2	-.1	
	STD RES	-1.4	3.5	-1.1	-.1	
	ADJ RES	-1.7	3.9	-1.2	-.1	
3.00 undec. rational	COUNT	2	1	2	9	14
	EXP VAL	3.8	1.6	2.4	6.2	14.7%
	ROW PCT	14.3%	7.1%	14.3%	64.3%	
	COL PCT	7.7%	9.1%	12.5%	21.4%	
	TOT PCT	2.1%	1.1%	2.1%	9.5%	
	RESIDUAL	-1.8	-.6	-.4	2.8	
	STD RES	-.9	-.5	-.2	1.1	
	ADJ RES	-1.2	-.6	-.3	1.6	
4.00 relat-cont A	COUNT	16	5	9	22	52
	EXP VAL	14.2	6.0	8.8	23.0	54.7%
	ROW PCT	30.8%	9.6%	17.3%	42.3%	
	COL PCT	61.5%	45.5%	56.3%	52.4%	
	TOT PCT	16.8%	5.3%	9.5%	23.2%	
	RESIDUAL	1.8	-1.0	.2	-1.0	
	STD RES	.5	-.4	.1	-.2	
	ADJ RES	.8	-.7	.1	-.4	
10.00	COUNT	[illegible]	1	5	8	22
	EXP VAL	[illegible]	2.5	3.7	9.7	23.2%
	ROW PCT	36.4%	4.5%	22.7%	36.4%	
	COL PCT	30.8%	9.1%	31.3%	19.0%	
	TOT PCT	8.4%	1.1%	5.3%	8.4%	
	RESIDUAL	2.0	-1.5	1.3	-1.7	
	STD RES	.8	-1.0	.7	-.6	
	ADJ RES	1.1	-1.2	.8	-.8	
COLUMN TOTAL		[illegible]	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
20.88377	9	0.0132	0.811	9 OF 16 (56.3%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.27070	
CONTINGENCY COEFFICIENT	0.42452	

WITH SC. KNOWLEDGE STATUS WITH LEARNING ASS

SC. KNOWLEDGE STATUS BY INTEGRATION

INTEGRATION

SC. KNOWLEDGE STATUS		emp-cont-prac 1.00	emp-else 2.00	int-comsr 3.00	int-prac 4.00	10.00	ROW TOTAL
2.00 prag-cont B	COUNT	5	0	2	0	0	7
	EXP VAL	1.7	.6	2.5	1.4	.8	7.4%
	ROW PCT	71.4%	.0%	28.6%	.0%	.0%	
	COL PCT	21.7%	.0%	5.9%	.0%	.0%	
	TOT PCT	5.3%	.0%	2.1%	.0%	.0%	
	RESIDUAL	3.3	-.6	-.5	1.4	-.8	
	STD RES	2.5	-.8	-.3	-1.2	-.9	
	ADJ RES	3.0	-.8	-.4	-1.4	1.0	
3.00 undec. rational	COUNT	4	0	4	6	0	14.
	EXP VAL	3.4	1.2	5.0	2.8	1.6	14.7%
	ROW PCT	28.6%	.0%	28.6%	42.9%	.0%	
	COL PCT	17.4%	.0%	11.8%	31.6%	.0%	
	TOT PCT	4.2%	.0%	4.2%	6.3%	.0%	
	RESIDUAL	.6	-1.2	-1.0	3.2	-1.6	
	STD RES	.3	-1.1	-.5	1.9	-1.3	
	ADJ RES	.4	-1.2	-.6	2.3	-1.5	
4.00 relat-cont A	COUNT	7	4	20	11	10	52
	EXP VAL	12.6	4.4	18.6	10.4	6.0	54.7%
	ROW PCT	13.5%	7.7%	38.5%	21.2%	19.2%	
	COL PCT	30.4%	50.0%	58.8%	57.9%	90.9%	
	TOT PCT	7.4%	4.2%	21.1%	11.6%	10.5%	
	RESIDUAL	-5.6	-.4	1.4	.6	4.0	
	STD RES	-1.6	-.2	.3	.2	1.6	
	ADJ RES	-2.7	-.3	.6	.3	2.6	
10.00	COUNT	7	4	8	2	1	22
	EXP VAL	5.3	1.9	7.9	4.4	2.5	23.2%
	ROW PCT	31.8%	18.2%	36.4%	9.1%	4.5%	
	COL PCT	30.4%	50.0%	23.5%	10.5%	9.1%	
	TOT PCT	7.4%	4.2%	8.4%	2.1%	1.1%	
	RESIDUAL	1.7	2.1	.1	-2.4	-1.5	
	STD RES	.7	1.6	.0	-1.1	-1.0	
	ADJ RES	1.0	1.9	.1	-1.5	-1.2	
COLUMN TOTAL		23	8	34	19	11	95
		24.2%	8.4%	35.8%	20.0%	11.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
26.66727	12	0.0086	0.589	13 OF 20 (65.0%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.30589	
CONTINGENCY COEFFICIENT	0.46817	

WITH SC. KNOWLEDGE STATUS WITH INTEGRATION

SC. KNOWLEDGE STATUS BY INSTRUCTION ASSUMPT

INSTRUCTION ASSUMPTIONS

SC. KNOWLEDGE STATUS	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	tch.sm. c.part 1.00	bal.sm.i nteg.par 2.00	bal.sm.o cc.part 3.00	bal.sm.i nteg.emo 4.00	bal.sm.o cc.emot 5.00	bal.id.o cc.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
2.00	COUNT	0	3	1	0	0	1	0	2	
prag cont A	EXP VAL	.4	.7	1.2	.7	.9	1.0	.2	1.9	7.
	ROW PCT	.0%	42.9%	14.3%	.0%	.0%	14.3%	.0%	28.6%	
	COL PCT	.0%	33.3%	6.3%	.0%	.0%	7.1%	.0%	7.7%	
	TOT PCT	.0%	3.2%	1.1%	.0%	.0%	1.1%	.0%	2.1%	
	RESIDUAL	-.4	2.3	-.2	-.7	-.9	.0	-.2	.1	
	STD RES	-.6	2.9	-.2	-.9	-.9	.0	-.5	.1	
	ADJ RES	-.6	3.1	-.2	-.9	-1.0	.0	-.5	.1	
3.00	COUNT	0	3	0	0	4	4	0	3	1
undec. rational	EXP VAL	.7	1.3	2.4	1.5	1.8	2.1	.4	3.8	14.
	ROW PCT	.0%	21.4%	.0%	.0%	28.6%	28.6%	.0%	21.4%	
	COL PCT	.0%	33.3%	.0%	.0%	33.3%	28.6%	.0%	11.5%	
	TOT PCT	.0%	3.2%	.0%	.0%	4.2%	4.2%	.0%	3.2%	
	RESIDUAL	-.7	1.7	-2.4	-1.5	2.2	1.9	-.4	-.8	
	STD RES	-.9	1.5	-1.5	-1.2	1.7	1.3	-.7	-.4	
	ADJ RES	-1.0	1.7	-1.8	-1.4	1.9	1.6	-.7	-.5	
4.00	COUNT	1	3	9	9	4	7	2	17	5
relat-cont A	EXP VAL	2.7	4.9	8.8	5.5	6.6	7.7	1.6	14.2	54.
	ROW PCT	1.9%	5.8%	17.3%	17.3%	7.7%	13.5%	3.8%	32.7%	
	COL PCT	20.0%	33.3%	56.3%	90.0%	33.3%	50.0%	66.7%	65.4%	
	TOT PCT	1.1%	3.2%	9.5%	9.5%	4.2%	7.4%	2.1%	17.9%	
	RESIDUAL	-1.7	-1.9	.2	3.5	-2.6	-.7	.4	2.8	
	STD RES	-1.0	-.9	.1	1.5	-1.0	-.2	.3	.7	
	ADJ RES	-1.[illegible]	-1.4	.1	2.4	-1.6	-.4	.4	1.3	
10.00	COUNT	4	0	6	1	4	2	1	4	2
	EXP VAL	1.2	2.1	3.7	2.3	2.8	3.2	.7	6.0	23.
	ROW PCT	18.2%	.0%	27.3%	4.5%	18.2%	9.1%	4.5%	18.2%	
	COL PCT	80.0%	.0%	37.5%	10.0%	33.3%	14.3%	33.3%	15.4%	
	TOT PCT	4.2%	.0%	6.3%	1.1%	4.2%	2.1%	1.1%	4.2%	
	RESIDUAL	2.8	-2.1	2.3	-1.3	1.2	-1.2	.3	-2.0	
	STD RES	2.6	-1.4	1.2	-.9	.7	-.7	.4	-.8	
	ADJ RES	3.1	-1.7	1.5	-1.0	.9	-.9	.4	-1.1	
COLUMN TOTAL		5	9	16	10	12	14	3	26	9
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
41.28042	21	0.0052	0.221	26 OF 32 (81.3%)

WITH SC. KNOWLEDGE STATUS WITH INSTRUCTION

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.38058	
CONTINGENCY COEFFICIENT	0.55037	

SC. KNOWLEDGE STATUS BY CLASSROOM ACTIVITIE

CLASSROOM ACTIVITIES

SC. KNOWLEDGE STATUS	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	teacher teacher 1.00	teacher pupil 2.00	pupil-te acher 3.00	pupil-pu pil 4.00	10.00	ROW TOTAL
2.00	COUNT	4	2	0	1	0	7
prag-cont A	EXP VAL	3.3	1.9	.5	1.1	.1	7.4%
	ROW PCT	57.1%	28.6%	.0%	14.3%	.0%	
	COL PCT	8.9%	7.7%	.0%	6.7%	.0%	
	TOT PCT	4.2%	2.1%	.0%	1.1%	.0%	
	RESIDUAL	.7	.1	-.5	-.1	-.1	
	STD RES	.4	.1	-.7	-.1	-.4	
	ADJ RES	.5	.1	-.8	-.1	-.4	
3.00	COUNT	6	7	1	0	0	14
undec. rational	EXP VAL	6.6	3.8	1.0	2.2	.3	14.7%
	ROW PCT	42.9%	50.0%	7.1%	.0%	.0%	
	COL PCT	13.3%	26.9%	14.3%	.0%	.0%	
	TOT PCT	6.3%	7.4%	1.1%	.0%	.0%	
	RESIDUAL	-.6	3.2	.0	-2.2	-.3	
	STD RES	-.2	1.6	.0	-1.5	-.5	
	ADJ RES	-.4	2.1	.0	-1.8	-.6	
4.00	COUNT	18	17	5	11	1	52
relat-cont A	EXP VAL	24.6	14.[illegible]	3.8	8.2	1.1	54.7%
	ROW PCT	34.6%	32.7%	9.6%	21.2%	1.9%	
	COL PCT	40.0%	65.4%	71.4%	73.3%	50.0%	
	TOT PCT	18.9%	17.[illegible]%	5.3%	11.6%	1.1%	
	RESIDUAL	-6.6	2.8	1.2	2.8	-.1	
	STD RES	-1.3	.[illegible]	.6	1.0	-.1	
	ADJ RES	-2.7	1.3	.9	1.6	-.1	
10.00	COUNT	17	0	1	3	1	22
	EXP VAL	10.4	6.0	1.6	3.5	.5	23.2%
	ROW PCT	77.3%	.0%	4.5%	13.6%	4.5%	
	COL PCT	37.8%	.0%	14.3%	20.0%	50.0%	
	TOT PCT	17.9%	.0%	1.1%	3.2%	1.1%	
	RESIDUAL	6.6	-6.0	-.6	-.5	.5	
	STD RES	2.0	-2.5	-.5	-.3	.8	
	ADJ RES	3.2	-3.3	-.6	-.3	.9	
COLUMN TOTAL		45	26	7	15	2	95
		47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
20.73986	12	0.0543	0.147	14 OF 20 (70.0%)

WITH SC. KNOWLEDGE STATUS WITH CLASSROOM A

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.26976	
CONTINGENCY COEFFICIENT	0.42331	

ISSUE OF REALITY BY "CONTENT" AND "PROC

"CONTENT" AND "PROCESS"

ISSUE OF REALITY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rel. law ls-exp 1.00	rel-fact s-meth 2.00	rel-fact s-exp 3.00	dist-fac ts-exp 4.00	dist-fac ts-meth 5.00	10.00	ROW TOTAL
2.00	COUNT	0	0	0	0	1	0	1
pragmatism	EXP VAL	.0	.2	.4	.1	.1	.1	1.1%
	ROW PCT	.0%	.0%	.0%	.0%	100.0%	.0%	
	COL PCT	.0%	.0%	.0%	.0%	10.0%	.0%	
	TOT PCT	.0%	.0%	.0%	.0%	1.1%	.0%	
	RESIDUAL	.0	-.2	-.4	-.1	.9	-.1	
	STD RES	-.2	-.5	-.7	-.3	2.8	-.4	
	ADJ RES	-.2	-.5	-.9	-.3	2.9	-.4	
3.00	COUNT	0	8	14	7	3	6	38
sc. realism	EXP VAL	1.6	8.0	16.8	2.8	4.0	4.8	40.0%
	ROW PCT	.0%	21.1%	36.8%	18.4%	7.9%	15.8%	
	COL PCT	.0%	40.0%	33.3%	100.0%	30.0%	50.0%	
	TOT PCT	.0%	8.4%	14.7%	7.4%	3.2%	6.3%	
	RESIDUAL	-1.6	.0	-2.8	4.2	-1.0	1.2	
	STD RES	-1.3	.0	-.7	2.5	-.5	.5	
	ADJ RES	-1.7	.0	-1.2	3.4	-.7	.8	
4.00	COUNT	0	0	14	0	2	5	21
idealism	EXP VAL	.9	4.4	9.3	1.5	2.2	2.7	22.1%
	ROW PCT	.0%	.0%	66.7%	.0%	9.5%	23.8%	
	COL PCT	.0%	.0%	33.3%	.0%	20.0%	41.7%	
	TOT PCT	.0%	.0%	14.7%	.0%	2.1%	5.3%	
	RESIDUAL	-.9	-4.4	4.7	-1.5	-.2	2.3	
	STD RES	-.9	-2.1	1.5	-1.2	-.1	1.4	
	ADJ RES	-1.1	-2.7	2.3	-1.5	-.2	1.7	
5.00	COUNT	0	2	1	0	0	0	3
scepticism	EXP VAL	.1	.6	1.3	.2	.3	.4	3.2%
	ROW PCT	.0%	66.7%	33.3%	.0%	.0%	.0%	
	COL PCT	.0%	10.0%	2.4%	.0%	.0%	.0%	
	TOT PCT	.0%	2.1%	1.1%	.0%	.0%	.0%	
	RESIDUAL	-.1	1.4	-.3	-.2	-.3	-.4	
	STD RES	-.4	1.7	-.3	-.5	-.6	-.6	
	ADJ RES	-.4	2.0	-.4	-.5	-.6	-.7	
10.00	COUNT	4	10	13	0	4	1	32
eclectic	EXP VAL	1.3	6.7	14.1	2.4	3.4	4.0	33.7%
	ROW PCT	12.5%	31.3%	40.6%	.0%	12.5%	3.1%	
	COL PCT	100.0%	50.0%	31.0%	.0%	40.0%	8.3%	
	TOT PCT	4.2%	10.5%	13.7%	.0%	4.2%	1.1%	
	RESIDUAL	2.7	3.3	-1.1	-2.4	.6	-3.0	
	STD RES	2.3	1.3	-.3	-1.5	.3	-1.5	
	ADJ RES	2.9	1.7	-.5	-2.0	.4	-2.0	
COLUMN TOTAL		4	20	42	7	10	12	95
		4.2%	21.1%	44.2%	7.4%	10.5%	12.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
44.51103	20	0.0013	0.042	25 OF 30 (83.3%)

STATISTIC	VALUE	WITH ISSUE OF REALITY SIGNIFICANCE	WITH "CONTENT" AND
CRAMER'S V	0.34225		
CONTINGENCY COEFFICIENT	0.56485		

CROSS TABULATION OF ISSUE OF REALITY BY INTEGRATION

INTEGRATION

ISSUE OF REALITY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	sep-cont prac 1.00	sep-elec 2.00	int-c-m- 3.00	int-prac 4.00	10.00	ROW TOTAL
2.00	COUNT	1	0	0	0	0	1
pragmatism	EXP VAL	.2	.1	.4	.2	.1	1.1%
	ROW PCT	100.0%	.0%	.0%	.0%	.0%	
	COL PCT	4.3%	.0%	.0%	.0%	.0%	
	TOT PCT	1.1%	.0%	.0%	.0%	.0%	
	RESIDUAL	.8	-.1	-.4	-.2	.1	
	STD RES	1.5	-.3	-.6	-.4	.3	
	ADJ RES	1.8	-.3	-.8	-.5	.4	
3.00	COUNT	14	4	10	7	3	38
sc. realism	EXP VAL	9.2	3.2	13.6	7.6	4.4	40.0%
	ROW PCT	36.8%	10.5%	26.3%	18.4%	7.9%	
	COL PCT	60.9%	50.0%	29.4%	36.8%	27.3%	
	TOT PCT	14.7%	4.2%	10.5%	7.4%	3.2%	
	RESIDUAL	4.8	.8	-3.6	-.6	-1.4	
	STD RES	1.6	.4	-1.0	-.2	-.7	
	ADJ RES	2.3	.6	-1.6	-.3	-.9	
4.00	COUNT	2	0	12	7	0	21
idealism	EXP VAL	5.1	1.8	7.5	4.2	2.4	22.1%
	ROW PCT	9.5%	.0%	57.1%	33.3%	.0%	
	COL PCT	8.7%	.0%	35.3%	36.8%	.0%	
	TOT PCT	2.1%	.0%	12.6%	7.4%	.0%	
	RESIDUAL	-3.1	-1.8	4.5	2.8	-2.4	
	STD RES	-1.4	-1.3	1.6	1.4	-1.6	
	ADJ RES	-1.8	-1.6	2.3	1.7	1.9	
5.00	COUNT	0	0	2	1	0	3
scepticism	EXP VAL	.7	.3	1.1	.6	.3	3.2%
	ROW PCT	.0%	.0%	66.7%	33.3%	.0%	
	COL PCT	.0%	.0%	5.9%	5.3%	.0%	
	TOT PCT	.0%	.0%	2.1%	1.1%	.0%	
	RESIDUAL	-.7	-.3	.9	.4	-.3	
	STD RES	-.9	-.5	.9	.5	-.6	
	ADJ RES	-1.0	-.5	1.1	.6	-.6	
10.00	COUNT	6	4	10	4	8	32
eclectic	EXP VAL	7.7	2.7	11.5	6.4	3.7	33.7%
	ROW PCT	18.8%	12.5%	31.3%	12.5%	25.0%	
	COL PCT	26.1%	50.0%	29.4%	21.1%	72.7%	
	TOT PCT	6.3%	4.2%	10.5%	4.2%	8.4%	
	RESIDUAL	-1.7	1.3	-1.5	-2.4	4.3	
	STD RES	-.6	.8	-.4	-.9	2.2	
	ADJ RES	-.9	1.0	-.7	-1.3	2.9	
COLUMN TOTAL		23	8	34	19	11	95
		24.2%	8.4%	35.8%	20.0%	11.6%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
27.37435	16	0.0375	0.084	17 OF 25 (68.0%)

STATISTIC	VALUE	WITH ISSUE OF REALITY SIGNIFICANCE	WITH INTEGRATION
CRAMER'S V	0.26840		
CONTINGENCY COEFFICIENT	0.47236		

ISSUE OF REALITY BY LEARNING ASSUMPTION

ISSUE OF REALITY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	cognitiv 1.00	behaviou 2.00	phenomen 3.00	10.00	ROW TOTAL
pragmatism 1.00	COUNT	1	0	0	0	1
	EXP VAL	.3	.1	.2	.4	1.1%
	ROW PCT	100.0%	.0%	.0%	.0%	
	COL PCT	3.8%	.0%	.0%	.0%	
	TOT PCT	1.1%	.0%	.0%	.0%	
	RESIDUAL	.7	-.1	-.2	-.4	
	STD RES	1.4	-.3	-.4	-.7	
	ADJ RES	1.6	-.4	-.5	-.9	
sc. realism 3.00	COUNT	7	3	10	18	38
	EXP VAL	10.4	4.4	6.4	16.8	40.0%
	ROW PCT	18.4%	7.9%	26.3%	47.4%	
	COL PCT	26.9%	27.3%	62.5%	42.9%	
	TOT PCT	7.4%	3.2%	10.5%	18.9%	
	RESIDUAL	-3.4	-1.4	3.6	1.2	
	STD RES	-1.1	-.7	1.4	.3	
	ADJ RES	-1.6	-.9	2.0	.5	
idealism 4.00	COUNT	7	2	0	12	21
	EXP VAL	5.7	2.4	3.5	9.3	22.1%
	ROW PCT	33.3%	9.5%	.0%	57.1%	
	COL PCT	26.9%	18.2%	.0%	28.6%	
	TOT PCT	7.4%	2.1%	.0%	12.6%	
	RESIDUAL	1.3	-.4	-3.5	2.7	
	STD RES	.5	-.3	-1.9	.9	
	ADJ RES	.7	-.3	-2.3	1.4	
scepticism 5.00	COUNT	1	1	0	1	3
	EXP VAL	.8	.3	.5	1.3	3.2%
	ROW PCT	33.3%	33.3%	.0%	33.3%	
	COL PCT	3.8%	9.1%	.0%	2.4%	
	TOT PCT	1.1%	1.1%	.0%	1.1%	
	RESIDUAL	.2	.7	-.5	-.3	
	STD RES	.2	1.1	-.7	-.3	
	ADJ RES	.2	1.2	-.8	-.4	
eclectic 10.00	COUNT	10	5	6	11	32
	EXP VAL	8.8	3.7	5.4	14.1	33.7%
	ROW PCT	31.3%	15.6%	18.8%	34.4%	
	COL PCT	38.5%	45.5%	37.5%	26.2%	
	TOT PCT	10.5%	5.3%	6.3%	11.6%	
	RESIDUAL	1.2	1.3	.6	-3.1	
	STD RES	.4	.7	.3	-.8	
	ADJ RES	.6	.9	.4	-1.4	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
14.25106	12	0.2850	0.116	12 OF 20 (60.0%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.22362	
CONTINGENCY COEFFICIENT	0.36117	

WITH ISSUE OF REALITY WITH LEARNING AS

ISSUE OF REALITY BY INSTRUCTION ASSUMPTIONS

ISSUE OF REALITY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	te..sm. occ.p..t 1.00	bal.cm.i nteg.p.. 2.00	bal.sm.o co.part 3.00	bal.sm.i nteg.emo 4.00	bal.sm.o co.e... 5.00	bal.id.o co.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
pragmatism 1.00	COUNT	0	0	0	0	1	0	0	0	1.
	EXP VAL	.1	.1	.2	.1	.1	.1	.0	.3	
	ROW PCT	.0%	.0%	.0%	.0%	100.0%	.0%	.0%	.0%	
	COL PCT	.0%	.0%	.0%	.0%	8.3%	.0%	.0%	.0%	
	TOT PCT	.0%	.0%	.0%	.0%	1.1%	.0%	.0%	.0%	
	RESIDUAL	-.1	-.1	-.2	-.1	.9	-.1	.0	-.3	
	STD RES	-.2	-.3	-.4	-.3	2.5	-.4	-.2	-.5	
	ADJ RES	-.2	-.3	-.5	-.3	2.6	-.4	-.2	-.6	
sc. realism 3.00	COUNT	1	3	7	2	7	7	2	9	40.
	EXP VAL	2.0	3.6	6.4	4.0	4.8	5.6	1.2	10.4	
	ROW PCT	2.6%	7.9%	18.4%	5.3%	18.4%	18.4%	5.3%	23.7%	
	COL PCT	20.0%	33.3%	43.8%	20.0%	58.3%	50.0%	66.7%	34.6%	
	TOT PCT	1.1%	3.2%	7.4%	2.1%	7.4%	7.4%	2.1%	9.5%	
	RESIDUAL	-1.0	-.6	.6	-2.0	2.2	1.4	.8	-1.4	
	STD RES	-.7	-.3	.2	-1.0	1.0	.6	.7	-.4	
	ADJ RES	-.9	-.4	.3	-1.4	1.4	.8	1.0	-.7	
idealism 4.00	COUNT	3	0	2	6	1	2	0	7	22.
	EXP VAL	1.1	2.0	3.5	2.2	2.7	3.1	.7	5.7	
	ROW PCT	14.3%	.0%	9.5%	28.6%	4.8%	9.5%	.0%	33.3%	
	COL PCT	60.0%	.0%	12.5%	60.0%	8.3%	14.3%	.0%	26.9%	
	TOT PCT	3.2%	.0%	2.1%	6.3%	1.1%	2.1%	.0%	7.4%	
	RESIDUAL	1.9	-2.0	-1.5	3.8	1.7	-1.1	-.7	1.3	
	STD RES	1.8	-1.4	-.8	2.5	-1.0	-.6	-.8	.5	
	ADJ RES	2.1	-1.7	-1.0	3.1	-1.[illegible]	-.8	-.9	.7	
scepticism 5.00	COUNT	0	1	0	0	2	0	0	0	3.
	EXP VAL	.2	.3	.5	.3	.4	.4	.1	.8	
	ROW PCT	.0%	33.3%	.0%	.0%	66.7%	.0%	.0%	.0%	
	COL PCT	.0%	11.1%	.0%	.0%	16.7%	.0%	.0%	.0%	
	TOT PCT	.0%	1.1%	.0%	.0%	2.1%	.0%	.0%	.0%	
	RESIDUAL	-.2	.7	-.5	-.3	1.6	-.4	-.1	-.8	
	STD RES	-.4	1.3	-.7	-.6	2.6	-.7	-.3	-.9	
	ADJ RES	-.4	1.4	-.8	-.6	2.9	-.7	-.3	-1.1	
eclectic 10.00	COUNT	1	5	7	2	1	5	1	10	33.
	EXP VAL	1.7	3.0	5.4	3.4	4.0	4.7	1.0	8.8	
	ROW PCT	3.1%	15.6%	21.9%	6.3%	3.1%	15.6%	3.1%	31.3%	
	COL PCT	20.0%	55.6%	43.8%	20.0%	8.3%	35.7%	33.3%	38.5%	
	TOT PCT	1.1%	5.3%	7.4%	2.1%	1.1%	5.3%	1.1%	10.5%	
	RESIDUAL	-.7	2.0	1.6	-1.4	-3.0	.3	.0	1.2	
	STD RES	-.5	1.1	.7	-.7	-1.5	.1	.0	.4	
	ADJ RES	-.7	1.5	.9	-1.0	-2.0	.2	.0	.6	
COLUMN TOTAL		5	9	16	10	12	14	3	26	
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
41.55794	28	0.0477	0.032	34 OF 40 (85.0%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.33070	
CONTINGENCY COEFFICIENT	0.55166	

WITH ISSUE OF REALITY WITH INSTRUCTION ASSU

'CONTENT' AND 'PROCESS' BY INTEGRATION

"CONTENT" AND "PROCESS"	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	rep-cont 1.00	sep-else 2.00	int-c-m st 3.00	int-prac 4.00	10.00	ROW TOTAL
1.00 rel-law	COUNT	0	0	3	0	1	4
	EXP VAL	1.0	.3	1.4	.6	.5	4.2%
	ROW PCT	.0%	.0%	75.0%	.0%	25.0%	
	COL PCT	.0%	.0%	8.8%	.0%	9.1%	
	TOT PCT	.0%	.0%	3.2%	.0%	1.1%	
	RESIDUAL	-1.0	-.3	1.6	-.8	.5	
	STD RES	-1.0	-.6	1.3	-.9	.8	
	ADJ RES	-1.2	-.6	1.7	-1.0	.9	
2.00 rel-facts-meth	COUNT	1	1	8	7	3	20
	EXP VAL	4.8	1.7	7.2	4.0	2.3	21.1%
	ROW PCT	5.0%	5.0%	40.0%	35.0%	15.0%	
	COL PCT	4.3%	12.5%	23.5%	36.8%	27.3%	
	TOT PCT	1.1%	1.1%	8.4%	7.4%	3.2%	
	RESIDUAL	-3.8	-.7	.8	3.0	.7	
	STD RES	-1.7	-.5	.3	1.5	.4	
	ADJ RES	-2.3	-.6	.4	1.9	.5	
3.00 rel-facts-exp	COUNT	9	4	19	5	5	42
	EXP VAL	10.2	3.5	15.0	8.4	4.9	44.2%
	ROW PCT	21.4%	9.5%	45.2%	11.9%	11.9%	
	COL PCT	39.1%	50.0%	55.9%	26.3%	45.5%	
	TOT PCT	9.5%	4.2%	20.0%	5.3%	5.3%	
	RESIDUAL	-1.2	.5	4.0	-3.4	.1	
	STD RES	-.4	.2	1.0	-1.2	.1	
	ADJ RES	-.6	.3	1.7	-1.8	.1	
4.00 dist-facts-exp	COUNT	1	3	0	3	0	7
	EXP VAL	1.7	.6	2.5	1.4	.8	7.4%
	ROW PCT	14.3%	42.9%	.0%	42.9%	.0%	
	COL PCT	4.3%	37.5%	.0%	15.8%	.0%	
	TOT PCT	1.1%	3.2%	.0%	3.2%	.0%	
	RESIDUAL	-.7	2.4	-2.5	1.6	-.8	
	STD RES	-.5	3.1	-1.6	1.4	-.9	
	ADJ RES	-.6	3.4	-2.1	1.6	-1.0	
5.00 dist-facts-meth	COUNT	7	0	1	2	0	10
	EXP VAL	2.4	.8	3.6	2.0	1.2	10.5%
	ROW PCT	70.0%	.0%	10.0%	20.0%	.0%	
	COL PCT	30.4%	.0%	2.9%	10.5%	.0%	
	TOT PCT	7.4%	.0%	1.1%	2.1%	.0%	
	RESIDUAL	4.6	-.8	-2.6	.0	-1.2	
	STD RES	2.9	-.9	-1.4	.0	-1.1	
	ADJ RES	3.6	-1.0	-1.8	.0	-1.2	
10.00	COUNT	5	0	3	2	2	12
	EXP VAL	2.9	1.0	4.3	2.4	1.4	12.6%
	ROW PCT	41.7%	.0%	25.0%	16.7%	16.7%	
	COL PCT	21.7%	.0%	8.8%	10.5%	18.2%	
	TOT PCT	5.3%	.0%	3.2%	2.1%	2.1%	
	RESIDUAL	2.1	-1.0	-1.3	-.4	.6	
	STD RES	1.2	-1.0	-.6	-.3	.5	
	ADJ RES	1.5	-1.1	-.8	-.3	.6	
COLUMN TOTAL		23 24.2%	8 8.4%	34 35.8%	19 20.0%	11 11.6%	95 100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5

ISSUE OF REALITY BY CLASSROOM ACTIVITIES

ISSUE OF REALITY	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
2.00 pragmatism	COUNT	1	0	0	0	0	1
	EXP VAL	.5	.3	.1	.2	.0	1.1%
	ROW PCT	100.0%	.0%	.0%	.0%	.0%	
	COL PCT	2.2%	.0%	.0%	.0%	.0%	
	TOT PCT	1.1%	.0%	.0%	.0%	.0%	
	RESIDUAL	.5	-.3	-.1	-.2	.0	
	STD RES	.8	-.5	-.3	-.4	-.1	
	ADJ RES	1.1	-.6	-.3	-.4	-.1	
3.00 sc. realism	COUNT	17	10	4	6	1	38
	EXP VAL	18.0	10.4	2.8	6.0	.8	40.0%
	ROW PCT	44.7%	26.3%	10.5%	15.8%	2.6%	
	COL PCT	37.8%	38.5%	57.1%	40.0%	50.0%	
	TOT PCT	17.9%	10.5%	4.2%	6.3%	1.1%	
	RESIDUAL	-1.0	-.4	1.2	.0	.2	
	STD RES	-.2	-.1	.7	.0	.2	
	ADJ RES	-.4	-.2	1.0	.0	.3	
4.00 idealism	COUNT	9	11	0	1	0	21
	EXP VAL	9.9	5.7	1.5	3.3	.4	22.1%
	ROW PCT	42.9%	52.4%	.0%	4.8%	.0%	
	COL PCT	20.0%	42.3%	.0%	6.7%	.0%	
	TOT PCT	9.5%	11.6%	.0%	1.1%	.0%	
	RESIDUAL	-.9	5.3	-1.5	-2.3	-.4	
	STD RES	-.3	2.2	-1.2	-1.3	-.7	
	ADJ RES	[illegible]	2.9	-1.5	-1.6	-.8	
5.00 scepticism	COUNT	1	1	0	1	0	3
	EXP VAL	1.4	.8	.2	.5	.1	3.2%
	ROW PCT	33.3%	33.3%	.0%	33.3%	.0%	
	COL PCT	2.2%	3.8%	.0%	6.7%	.0%	
	TOT PCT	1.1%	1.1%	.0%	1.1%	.0%	
	RESIDUAL	-.4	.2	-.2	.5	-.1	
	STD RES	-.4	.2	-.5	.8	-.3	
	ADJ RES	-.5	.2	-.5	.8	-.3	
10.00 eclectic	COUNT	17	4	3	7	1	32
	EXP VAL	15.2	8.8	2.4	5.1	[illegible]	33.7%
	ROW PCT	53.1%	12.5%	9.4%	21.9%	3.1%	
	COL PCT	37.8%	15.4%	42.9%	46.7%	50.0%	
	TOT PCT	17.9%	4.2%	3.2%	7.4%	1.1%	
	RESIDUAL	1.8	-4.8	.6	1.9	[illegible]	
	STD RES	.5	-1.6	.4	.9	.4	
	ADJ RES	.8	-2.3	.5	1.2	[illegible]	
COLUMN TOTAL		45 47.4%	26 27.4%	7 7.4%	15 15.8%	2 2.1%	95 100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
15.16880	16	0.5123	0.021	17 OF 25 (68.0%)

STATISTIC	VALUE	WITH ISSUE OF REALITY SIGNIFICANCE	WITH CLASSROOM ACTIVI
CRAMER'S V	0.15979		
CONTINGENCY COEFFICIENT	0.37106		

CROSSTABULATION OF "CONTENT" AND "PROCESS" BY LEARNING ASSUMPTIO

LEARNING ASSUMPTIONS

"CONTENT" AND "PROCESS"	COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES	cognitive 1.00	behaviour 2.00	phenomen 3.00	10.00	ROW TOTAL
1.00	COUNT	1	0	3	0	4
rel.-laws-exp	EXP VAL	1.1	.5	.7	1.8	4.2%
	ROW PCT	25.0%	.0%	75.0%	.0%	
	COL PCT	3.8%	.0%	18.8%	.0%	
	TOT PCT	1.1%	.0%	3.2%	.0%	
	RESIDUAL	-.1	-.5	2.3	-1.8	
	STD RES	-.1	-.7	2.8	-1.3	
	ADJ RES	-.1	-.7	3.2	-1.8	
2.00	COUNT	2	4	5	9	20
rel-facts-meth	EXP VAL	5.5	2.3	3.4	8.8	21.1%
	ROW PCT	10.0%	20.0%	25.0%	45.0%	
	COL PCT	7.7%	36.4%	31.3%	21.4%	
	TOT PCT	2.1%	4.2%	5.3%	9.5%	
	RESIDUAL	-3.5	1.7	1.6	.2	
	STD RES	-1.5	1.1	.9	.1	
	ADJ RES	-2.0	1.3	1.1	.1	
3.00	COUNT	19	2	2	19	42
rel-facts-exp	EXP VAL	11.5	4.9	7.1	18.6	44.2%
	ROW PCT	45.2%	4.8%	4.8%	45.2%	
	COL PCT	73.1%	18.2%	12.5%	45.2%	
	TOT PCT	20.0%	2.1%	2.1%	20.0%	
	RESIDUAL	7.5	-2.9	-5.1	.4	
	STD RES	2.2	-1.3	-1.9	.1	
	ADJ RES	3.5	-1.8	-2.8	.2	
4.00	COUNT	3	0	2	2	7
dist-facts-exp	EXP VAL	1.9	.8	1.2	3.1	7.4%
	ROW PCT	42.9%	.0%	28.6%	28.6%	
	COL PCT	11.5%	.0%	12.5%	4.8%	
	TOT PCT	3.2%	.0%	2.1%	2.1%	
	RESIDUAL	1.1	-.8	.8	-1.1	
	STD RES	.8	-.9	.8	-.6	
	ADJ RES	1.0	-1.0	.9	-.9	
5.00	COUNT	1	3	1	5	10
dist-facts-meth	EXP VAL	2.7	1.2	1.7	4.4	10.5%
	ROW PCT	10.0%	30.0%	10.0%	50.0%	
	COL PCT	3.8%	27.3%	6.3%	11.9%	
	TOT PCT	1.1%	3.2%	1.1%	5.3%	
	RESIDUAL	-1.7	1.8	-.7	.6	
	STD RES	-1.0	1.7	-.5	.3	
	ADJ RES	-1.3	1.9	-.6	.4	
10.00	COUNT	0	2	3	7	12
	EXP VAL	3.3	1.4	2.0	5.3	12.6%
	ROW PCT	.0%	16.7%	25.0%	58.3%	
	COL PCT	.0%	18.2%	18.8%	16.7%	
	TOT PCT	.0%	2.1%	3.2%	7.4%	
	RESIDUAL	-3.3	.6	1.0	1.7	
	STD RES	-1.8	.5	.7	.7	
	ADJ RES	-2.3	.6	.8	1.1	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
36.06837	15	0.0017	0.463	18 OF 24 (75.0%)

STATISTIC	VALUE	SIGNIFICANCE
		WITH "CONTENT" AND "PROCESS"
		WITH LEARNING A
CRAMER'S V	0.35575	
CONTINGENCY COEFFICIENT	0.52458	

"CONTENT" AND "PROCESS" BY INSTRUCTION ASSUMP

INSTRUCTION ASSUMPTIONS

COUNT
EXP VAL
ROW PCT
COL PCT
TOT PCT
RESIDUAL
STD RES
ADJ RES

"CONTENT" AND "PROCESS"	tech.sm.occ.part 1.00	bal.sm.integ.oar 2.00	bal.sm.occ.part 3.00	bal.sm.integ.emo 4.00	ba..sm.occ.emot 5.00	bal.id.occ.part 6.00	bal.id.integ.emo 7.00	10.00	RO TOT
1.00	0	0	0	0	0	3	0	1	
rel.-laws-exp	.2	.4	.7	.4	.5	.6	.1	1.1	4.
	.0%	.0%	.0%	.0%	.0%	75.0%	.0%	25.0%	
	.0%	.0%	.0%	.0%	.0%	21.4%	.0%	3.8%	
	.0%	.0%	.0%	.0%	.0%	3.2%	.0%	1.1%	
	-.2	-.4	-.7	-.4	-.5	2.4	-.1	-.1	
	-.5	-.6	-.8	-.6	-.7	3.1	-.4	-.1	
	-.5	-.7	-.9	-.7	-.8	3.5	-.4	-.1	
2.00	1	0	1	1	3	4	1	9	2
rel-facts-meth	1.1	1.9	3.4	2.1	2.5	2.9	.6	5.5	21.
	5.0%	.0%	5.0%	5.0%	15.0%	20.0%	5.0%	45.0%	
	20.0%	.0%	6.3%	10.0%	25.0%	28.6%	33.3%	34.6%	
	1.1%	.0%	1.1%	1.1%	3.2%	4.2%	1.1%	9.5%	
	-.1	-1.9	-2.4	-1.1	.5	1.1	.4	3.5	
	-.1	-1.4	-1.3	-.8	.3	.6	.5	1.5	
	-.1	-1.6	-1.6	-.9	.4	.7	.5	2.0	
3.00	4	3	12	8	1	4	1	9	4
rel-facts-exp	2.2	4.0	7.1	4.4	5.3	6.2	1.3	11.5	44.
	9.5%	7.1%	28.6%	19.0%	2.4%	9.5%	2.4%	21.4%	
	80.0%	33.3%	75.0%	80.0%	8.3%	28.6%	33.3%	34.6%	
	4.2%	3.2%	12.6%	8.4%	1.1%	4.2%	1.1%	9.5%	
	1.8	-1.0	4.9	3.6	-4.3	-2.2	-.3	-2.5	
	1.2	-.5	1.9	1.7	-1.9	-.9	-.2	-.7	
	1.7	-.7	2.7	2.4	-2.7	-1.3	-.4	-1.2	
4.00	0	3	3	0	0	1	0	0	
dist-facts-exp	.4	.7	1.2	.7	.9	1.0	.2	1.9	[illegible]
	.0%	42.9%	42.9%	.0%	.0%	14.3%	.0%	.0%	
	.0%	33.3%	18.8%	.0%	.0%	7.1%	.0%	.0%	
	.0%	3.2%	3.2%	.0%	.0%	1.1%	.0%	.0%	
	-.4	2.3	1.8	-.7	-.9	.0	-.2	-1.9	
	-.6	2.9	1.7	-.9	-.9	.0	-.5	-1.4	
	-.6	3.1	1.9	-.9	-1.0	.0	-.5	-1.7	
5.00	0	3	0	0	4	0	1	2	1
dist-facts-meth	.5	.9	1.7	1.1	1.3	1.5	.3	2.7	10.
	.0%	30.0%	.0%	.0%	40.0%	.0%	10.0%	20.0%	
	.0%	33.3%	.0%	.0%	33.3%	.0%	33.3%	7.7%	
	.0%	3.2%	.0%	.0%	4.2%	.0%	1.1%	2.1%	
	-.5	2.1	-1.7	-1.1	2.7	-1.5	.7	-.7	
	-.7	2.1	-1.3	-1.0	2.4	-1.2	1.2	-.4	
	-.8	2.3	-1.5	-1.1	2.8	-1.4	1.3	-.6	
10.00	0	0	0	1	4	2	0	5	1
	.6	1.1	2.0	1.3	1.5	1.8	.4	3.3	12.
	.0%	.0%	.0%	8.3%	33.3%	16.7%	.0%	41.7%	
	.0%	.0%	.0%	10.0%	33.3%	14.3%	.0%	19.2%	
	.0%	.0%	.0%	1.1%	4.2%	2.1%	.0%	5.3%	
	-.6	-1.1	-2.0	-.3	2.5	.2	-.4	1.7	
	-.8	-1.1	-1.4	-.2	2.0	.2	-.6	.9	
	-.9	-1.2	-1.7	-.3	2.3	.2	-.7	1.2	
COLUMN	5	9	16	10	12	14	3	26	9
TOTAL	5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. (5
73.37411	35	0.0002	0.126	43 OF 48 (89.6%)

WITH "CONTENT" AND "PROCESS" WITH INSTRUCTION

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.37303	
CONTINGENCY COEFFICIENT	0.66014	

"CONTENT" AND "PROCESS" BY CLASSROOM ACTIVITI

CLASSROOM ACTIVITIES

COUNT
EXP VAL
ROW PCT
COL PCT
TOT PCT
RESIDUAL
STD RES
ADJ RES

"CONTENT" AND "PROCESS"	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
1.00	0	0	3	1	0	4
rel.-laws-exp	1.9	1.1	.3	.6	.1	4.2%
	.0%	.0%	75.0%	25.0%	.0%	
	.0%	.0%	42.9%	6.7%	.0%	
	.0%	.0%	3.2%	1.1%	.0%	
	-1.9	-1.1	2.7	.4	-.1	
	-1.4	-1.0	5.0	.5	-.3	
	-1.9	-1.3	5.3	.5	-.3	
2.00	8	3	2	7	0	20
rel-facts-meth	9.5	5.5	1.5	3.2	.4	21.1%
	40.0%	15.0%	10.0%	35.0%	.0%	
	17.8%	11.5%	28.6%	46.7%	.0%	
	8.4%	3.2%	2.1%	7.4%	.0%	
	-1.5	-2.5	.5	3.8	-.4	
	-.5	-1.1	.4	2.2	-.6	
	-.7	-1.4	.5	2.7	-.7	
3.00	19	16	1	4	2	42
rel-facts-exp	19.9	11.5	3.1	6.6	.9	44.2%
	45.2%	38.1%	2.4%	9.5%	4.8%	
	42.2%	61.5%	14.3%	26.7%	100.0%	
	20.0%	16.8%	1.1%	4.2%	2.1%	
	-.9	4.5	-2.1	-2.6	1.1	
	-.2	1.3	-1.2	-1.0	1.2	
	-.4	2.1	-1.7	-1.5	1.6	
4.00	4	3	0	0	0	7
dist-facts-exp	3.3	1.9	.5	1.1	.1	7.4%
	57.1%	42.9%	.0%	.0%	.0%	
	8.9%	11.5%	.0%	.0%	.0%	
	4.2%	3.2%	.0%	.0%	.0%	
	.7	1.1	-.5	-1.1	-.1	
	.4	.8	-.7	-1.1	-.4	
	.5	1.0	-.8	-1.2	-.4	
5.00	7	2	0	1	0	10
dist-facts-meth	4.7	2.7	.7	1.6	.2	10.5%
	70.0%	20.0%	.0%	10.0%	.0%	
	15.6%	7.7%	.0%	6.7%	.0%	
	7.4%	2.1%	.0%	1.1%	.0%	
	2.3	-.7	-.7	-.6	-.2	
	1.0	-.4	-.9	-.5	-.5	
	1.5	-.6	-.9	-.5	-.5	
10.00	7	2	1	2	0	12
	5.7	3.3	.9	1.9	.3	12.6%
	58.3%	16.7%	8.3%	16.7%	.0%	
	15.6%	7.7%	14.3%	13.3%	.0%	
	7.4%	2.1%	1.1%	2.1%	.0%	
	1.3	-1.3	.1	.1	-.3	
	.6	-.7	.1	.1	-.5	
	.8	-.9	.1	.1	-.5	
COLUMN	45	26	7	15	2	95
TOTAL	47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. (5
46.46887	20	0.0007	0.084	24 OF 30 (80.0%)

WITH "CONTENT" AND "PROCESS" WITH CLASSROOM

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.34969	
CONTINGENCY COEFFICIENT	0.57313	

INTEGRATION BY LEARNING ASSUMPTIONS

INTEGRATION		LEARNING ASSUMPTIONS: 1.00 cognitiv beh. [illegible] phenomen	2.00	3.00	10.00	ROW TOTAL
1.00 sep-cont-pr.	COUNT	5	5	4	9	23
	EXP VAL	6.3	2.7	3.9	10.2	24.2%
	ROW PCT	21.7%	21.7%	17.4%	39.1%	
	COL PCT	19.2%	45.5%	25.0%	21.4%	
	TOT PCT	5.3%	5.3%	4.2%	9.5%	
	RESIDUAL	-1.3	2.3	.1	-1.2	
	STD RES	-.5	1.4	.1	-.4	
	ADJ RES	-.7	1.7	.1	-.6	
2.00 sep-else	COUNT	6	0	0	2	8
	EXP VAL	2.2	.9	1.3	3.5	8.4%
	ROW PCT	75.0%	.0%	.0%	25.0%	
	COL PCT	23.1%	.0%	.0%	4.8%	
	TOT PCT	6.3%	.0%	.0%	2.1%	
	RESIDUAL	3.8	-.9	-1.3	-1.5	
	STD RES	2.6	-1.0	-1.2	-.8	
	ADJ RES	3.2	-1.1	-1.3	-1.1	
3.00 int-c-m-sr	COUNT	8	4	8	14	34
	EXP VAL	9.3	3.9	5.7	15.0	35.8%
	ROW PCT	23.5%	11.8%	23.5%	41.2%	
	COL PCT	30.8%	36.4%	50.0%	33.3%	
	TOT PCT	8.4%	4.2%	8.4%	14.7%	
	RESIDUAL	-1.3	.1	2.3	-1.0	
	STD RES	-.4	.0	1.0	-.3	
	ADJ RES	-.6	.0	1.3	-.4	
4.00 int-prac	COUNT	3	1	4	11	19
	EXP VAL	5.2	2.2	3.2	8.4	20.0%
	ROW PCT	15.8%	5.3%	21.1%	57.9%	
	COL PCT	11.5%	9.1%	25.0%	26.2%	
	TOT PCT	3.2%	1.1%	4.2%	11.6%	
	RESIDUAL	-2.2	-1.2	.8	2.6	
	STD RES	-1.0	-.8	.4	.9	
	ADJ RES	-1.3	-1.0	.5	1.3	
10.00	COUNT	4	1	0	6	11
	EXP VAL	3.0	1.3	1.9	4.9	11.6%
	ROW PCT	36.4%	9.1%	.0%	54.5%	
	COL PCT	15.4%	9.1%	.0%	14.3%	
	TOT PCT	4.2%	1.1%	.0%	6.3%	
	RESIDUAL	1.0	-.3	-1.9	1.1	
	STD RES	.6	-.2	-1.4	.5	
	ADJ RES	.7	-.3	-1.6	.7	
COLUMN TOTAL		26	11	16	42	95
		27.4%	11.6%	16.8%	44.2%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
18.27862	12	0.1075	0.926	13 OF 20 (65.0%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.25325	
CONTINGENCY COEFFICIENT	0.40170	

WITH INTEGRATION WITH LEARNING ASSUMPT

INTEGRATION BY INSTRUCTION ASSUMPTIONS

INTEGRATION		INSTRUCTION ASSUMPTIONS: 1.00 tech.sm. corr.part	2.00 bal.sm.i nteg.pa	3.00 bal.sm.o cc.part	4.00 bal.[illegible].i nteg.emo	5.00 bal.[illegible].o cc.emot	6.00 bal.id.o cc.part	7.00 bal.id.i nteg.emo	10.00	ROW TOTAL
1.00 sep-cont-prac	COUNT	0	3	5	0	7	3	2	3	
	EXP VAL	1.2	2.2	3.9	2.4	[illegible]	3.4	.7	6.3	24.
	ROW PCT	.0%	13.0%	21.7%	.0%	30.4%	13.0%	8.7%	13.0%	
	COL PCT	.0%	33.3%	31.3%	.0%	58.3%	21.4%	66.7%	11.5%	
	TOT PCT	.0%	3.2%	5.3%	.0%	7.4%	3.2%	2.1%	3.2%	
	RESIDUAL	-1.2	.8	1.1	-2.4	4.1	-.4	1.3	-3.3	
	STD RES	-1.1	.6	.6	-1.6	2.4	-.2	1.5	-1.3	
	ADJ RES	-1.3	.7	.7	-1.9	3.0	-.3	1.7	-1.8	
2.00 sep-else	COUNT	0	2	3	2	0	0	0	1	
	EXP VAL	.4	.8	1.3	.8	1.0	1.2	.3	2.2	8.
	ROW PCT	.0%	25.0%	37.5%	25.0%	.0%	.0%	.0%	12.5%	
	COL PCT	.0%	22.2%	18.8%	20.0%	.0%	.0%	.0%	3.8%	
	TOT PCT	.0%	2.1%	3.2%	2.1%	.0%	.0%	.0%	1.1%	
	RESIDUAL	-.4	1.2	1.7	1.2	-1.0	-1.2	-.3	-1.2	
	STD RES	-.6	1.4	1.4	1.3	-1.0	-1.1	-.5	-.8	
	ADJ RES	-.7	1.6	1.6	1.4	-1.1	-1.2	-.5	-1.0	
3.00 int-c-m-sr	COUNT	4	1	4	3	2	9	1	10	3
	EXP VAL	1.8	3.2	5.7	3.6	4.3	5.0	1.1	9.3	35.
	ROW PCT	11.8%	2.9%	11.8%	8.8%	5.9%	26.5%	2.9%	29.4%	
	COL PCT	80.0%	11.1%	25.0%	30.0%	16.7%	64.3%	33.3%	38.5%	
	TOT PCT	4.2%	1.1%	4.2%	3.2%	2.1%	9.5%	1.1%	10.5%	
	RESIDUAL	2.2	-2.2	-1.7	-.6	-2.3	4.0	-.1	.7	
	STD RES	1.7	-1.2	-.7	-.3	-1.1	1.8	-.1	.2	
	ADJ RES	2.1	-1.6	-1.0	-.4	-1.5	2.4	-.1	.3	
4.00 int-prac	COUNT	0	3	1	4	2	1	0	8	
	EXP VAL	1.0	1.8	3.2	2.0	2.4	2.8	.6	5.2	20.
	ROW PCT	.0%	15.8%	5.3%	21.1%	10.5%	5.3%	.0%	42.1%	
	COL PCT	.0%	33.3%	6.3%	40.0%	16.7%	7.1%	.0%	30.8%	
	TOT PCT	.0%	3.2%	1.1%	4.2%	2.1%	1.1%	.0%	8.4%	
	RESIDUAL	-1.0	1.2	-2.2	2.0	-.4	-1.8	-.6	2.8	
	STD RES	-1.0	.9	-1.2	1.4	-.3	-1.1	-.8	1.2	
	ADJ RES	-1.1	1.1	-1.5	1.7	-.3	-1.3	-.9	1.6	
10.00	COUNT	1	0	3	1	1	1	0	4	
	EXP VAL	.6	1.0	1.9	1.2	1.4	1.6	.3	3.0	11.
	ROW PCT	9.1%	.0%	27.3%	9.1%	9.1%	9.1%	.0%	36.4%	
	COL PCT	20.0%	.0%	18.8%	10.0%	8.3%	7.1%	.0%	15.4%	
	TOT PCT	1.1%	.0%	3.2%	1.1%	1.1%	1.1%	.0%	4.2%	
	RESIDUAL	.4	-1.0	1.1	-.2	-.4	-.6	-.3	1.0	
	STD RES	.6	-1.0	.8	-.1	-.3	-.5	-.6	.6	
	ADJ RES	.6	-1.1	1.0	-.2	-.4	-.6	-.6	.7	
COLUMN TOTAL		5	9	16	10	12	14	3	26	9
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
44.28655	28	0.0260	0.253	35 OF 40 (87.5%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.34138	
CONTINGENCY COEFFICIENT	0.56387	

WITH INTEGRATION WITH INSTRUCTION ASSUMPTION

INTEGRATION BY CLASSROOM ACTIVITIES

CLASSROOM ACTIVITIES

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

INTEGRATION		teacher- teacher pupil 1.00	teacher- pupil 2.00	pupil-te acher 3.00	pupil-pu pil 4.00	10.00	ROW TOTAL
1.00 sep-cont-prac	COUNT	19	3	0	1	0	23
	EXP VAL	10.9	6.3	1.7	3.6	.5	24.2%
	ROW PCT	82.6%	13.0%	.0%	4.3%	.0%	
	COL PCT	42.2%	11.5%	.0%	6.7%	.0%	
	TOT PCT	20.0%	3.2%	.0%	1.1%	.0%	
	RESIDUAL	8.1	-3.3	-1.7	-2.6	-.5	
	STD RES	2.5	-1.3	-1.3	-1.4	-.7	
	ADJ RES	3.9	-1.8	-1.6	-1.7	-.8	
2.00 sep-else	COUNT	5	0	0	2	1	8
	EXP VAL	3.8	2.2	.6	1.3	.2	8.4%
	ROW PCT	62.5%	.0%	.0%	25.0%	12.5%	
	COL PCT	11.1%	.0%	.0%	13.3%	50.0%	
	TOT PCT	5.3%	.0%	.0%	2.1%	1.1%	
	RESIDUAL	1.2	-2.2	-.6	.7	.8	
	STD RES	.6	-1.5	-.8	.7	2.0	
	ADJ RES	.9	-1.8	-.8	.7	2.1	
3.00 int-c-m-sr	COUNT	12	8	4	9	1	34
	EXP VAL	16.1	9.3	2.5	5.4	.7	35.8%
	ROW PCT	35.3%	23.5%	11.8%	26.5%	2.9%	
	COL PCT	26.7%	30.8%	57.1%	60.0%	50.0%	
	TOT PCT	12.6%	8.4%	4.2%	9.5%	1.1%	
	RESIDUAL	-4.1	-1.3	1.5	3.6	.3	
	STD RES	-1.0	-.4	.9	1.6	.3	
	ADJ RES	-1.8	-.6	1.2	2.1	.4	
4.00 int-prac	COUNT	6	11	1	1	0	19
	EXP VAL	9.0	5.2	1.4	3.0	.4	20.0%
	ROW PCT	31.6%	57.9%	5.3%	5.3%	.0%	
	COL PCT	13.3%	42.3%	14.3%	6.7%	.0%	
	TOT PCT	6.3%	11.6%	1.1%	1.1%	.0%	
	RESIDUAL	-3.0	5.8	-.4	-2.0	-.4	
	STD RES	-1.0	2.5	-.3	-1.2	-.6	
	ADJ RES	-1.5	3.3	-.4	-1.4	-.7	
10.00	COUNT	3	4	2	2	0	11
	EXP VAL	5.2	3.0	.8	1.7	.2	11.6%
	ROW PCT	27.3%	36.4%	18.2%	18.2%	.0%	
	COL PCT	6.7%	15.4%	28.6%	13.3%	.0%	
	TOT PCT	3.2%	4.2%	2.1%	2.1%	.0%	
	RESIDUAL	-2.2	1.0	1.2	.3	-.2	
	STD RES	-1.0	.6	1.3	.2	-.5	
	ADJ RES	-1.4	.7	1.5	.2	-.5	
COLUMN TOTAL		45	26	7	15	2	95
		47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
36.82953	16	0.0022	0.168	17 OF 25 (68.0%)

STATISTIC	VALUE	SIGNIFICANCE
		WITH INTEGRATION / WITH CLASSROOM ACTIVIT
CRAMER'S V	0.31132	
CONTINGENCY COEFFICIENT	0.52856	

LEARNING ASSUMPTIONS BY INSTRUCTION ASSUMPTI

INSTRUCTION ASSUMPTIONS

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

LEARNING ASSUMPTIONS		tech.sm. occ.part 1.00	bal.sm.i nteg.p 2.00	b...sm.o cc.part 3.00	bal.sm.i nteg.emo 4.00	bal.sm.o cc.emot 5.00	bal.id.o cc.part 6.00	bal.id.i nteg.emo 7.00	10.00	ROW TOTAL
1.00 cognitive	COUNT	0	2	10	7	2	2	0	3	
	EXP VAL	1.4	2.5	4.4	2.7	3.3	3.8	.8	7.1	27.
	ROW PCT	.0%	7.7%	38.5%	26.9%	7.7%	7.7%	.0%	11.5%	
	COL PCT	.0%	22.2%	62.5%	70.0%	16.7%	14.3%	.0%	11.5%	
	TOT PCT	.0%	2.1%	10.5%	7.4%	2.1%	2.1%	.0%	3.2%	
	RESIDUAL	-1.4	-.5	5.6	4.3	-1.3	-1.8	-.8	-4.1	
	STD RES	-1.2	-.3	2.7	2.6	-.7	-.9	-.9	-1.5	
	ADJ RES	-1.4	-.4	3.5	3.2	-.9	-1.2	-1.1	-2.1	
2.00 behaviour.	COUNT	1	3	0	0	1	1	1	4	
	EXP VAL	.6	1.0	1.9	1.2	1.4	1.6	.3	3.0	11.
	ROW PCT	9.1%	27.3%	.0%	.0%	9.1%	9.1%	9.1%	36.4%	
	COL PCT	20.0%	33.3%	.0%	.0%	8.3%	7.1%	33.3%	15.4%	
	TOT PCT	1.1%	3.2%	.0%	.0%	1.1%	1.1%	1.1%	4.2%	
	RESIDUAL	.4	2.0	-1.9	-1.2	-.4	-.6	.7	1.0	
	STD RES	.6	1.9	-1.4	-1.1	-.3	-.5	1.1	.6	
	ADJ RES	.6	2.1	-1.6	-1.2	-.4	-.6	1.2	.7	
3.00 phenomen.	COUNT	0	2	2	0	4	3	2	3	1
	EXP VAL	.8	1.5	2.7	1.7	2.0	2.4	.5	4.4	16.
	ROW PCT	.0%	12.5%	12.5%	.0%	25.0%	18.8%	12.5%	18.8%	
	COL PCT	.0%	22.2%	12.5%	.0%	33.3%	21.4%	66.7%	11.5%	
	TOT PCT	.0%	2.1%	2.1%	.0%	4.2%	3.2%	2.1%	3.2%	
	RESIDUAL	-.8	.5	-.7	-1.7	2.0	.6	1.5	-1.4	
	STD RES	-.9	.4	-.4	-1.3	1.4	.4	2.1	-.7	
	ADJ RES	-1.0	.5	-.5	-1.5	1.6	.5	2.3	-.8	
10.00	COUNT	4	2	4	3	5	8	0	16	4
	EXP VAL	2.2	4.0	7.1	4.4	5.3	6.2	1.3	11.5	44.
	ROW PCT	9.5%	4.8%	9.5%	7.1%	11.9%	19.0%	.0%	38.1%	
	COL PCT	80.0%	22.2%	25.0%	30.0%	41.7%	57.1%	.0%	61.5%	
	TOT PCT	4.2%	2.1%	4.2%	3.2%	5.3%	8.4%	.0%	16.8%	
	RESIDUAL	1.8	-2.0	-3.1	-1.4	-.3	1.8	-1.3	4.5	
	STD RES	1.2	-1.0	-1.2	-.7	-.1	.7	-1.2	1.3	
	ADJ RES	1.7	-1.4	-1.7	-1.0	-.2	1.1	-1.6	2.1	
COLUMN TOTAL		5	9	16	10	12	14	3	26	9
		5.3%	9.5%	16.8%	10.5%	12.6%	14.7%	3.2%	27.4%	100.

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.< 5
46.47805	21	0.0011	0.347	27 OF 32 (84.4%)

STATISTIC	VALUE	SIGNIFICANCE
		WITH LEARNING ASSUMPTIONS / WITH INSTRUCTION
CRAMER'S V	0.40383	
CONTINGENCY COEFFICIENT	0.57316	

INSTRUCTION ASSUMPTIONS BY CLASSROOM ACTIVITIES

CLASSROOM ACTIVITIES

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

INSTRUCTION ASSUMPTIONS	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
1.00 tech.sm.occ.part	4	0	0	0	1	5
	2.4	1.4	.4	.8	.1	5.3%
	80.0%	.0%	.0%	.0%	20.0%	
	8.9%	.0%	.0%	.0%	50.0%	
	4.2%	.0%	.0%	.0%	1.1%	
	1.6	-1.4	-.4	-.8	.9	
	1.1	-1.2	-.6	-.9	2.8	
	1.5	-1.4	-.6	-1.0	2.9	
2.00 bal.sm.integ.par	5	3	0	1	0	9
	4.3	2.5	.7	1.4	.2	9.5%
	55.6%	33.3%	.0%	11.1%	.0%	
	11.1%	11.5%	.0%	6.7%	.0%	
	5.3%	3.2%	.0%	1.1%	.0%	
	.7	.5	-.7	-.4	-.2	
	.4	.3	-.8	-.4	-.4	
	.5	.4	-.9	-.4	-.5	
3.00 bal.sm.occ.part	8	6	0	2	0	16
	7.6	4.4	1.2	2.5	.3	16.8%
	50.0%	37.5%	.0%	12.5%	.0%	
	17.8%	23.1%	.0%	13.3%	.0%	
	8.4%	6.3%	.0%	2.1%	.0%	
	.4	1.6	-1.2	-.5	-.3	
	.2	.8	-1.1	-.3	-.6	
	.2	1.0	-1.2	-.4	-.6	
4.00 bal.sm.integ.emo	1	7	0	2	0	10
	4.7	2.7	.7	1.6	.2	10.5%
	10.0%	70.0%	.0%	20.0%	.0%	
	2.2%	26.9%	.0%	13.3%	.0%	
	1.1%	7.4%	.0%	2.1%	.0%	
	-3.7	4.3	-.7	.4	-.2	
	-1.7	2.6	-.9	.3	-.5	
	-2.5	3.2	-.9	.4	-.5	
5.00 bal.sm.occ.emot	9	1	1	1	0	12
	5.7	3.3	.9	1.9	.3	12.6%
	75.0%	8.3%	8.3%	8.3%	.0%	
	20.0%	3.8%	14.3%	6.7%	.0%	
	9.5%	1.1%	1.1%	1.1%	.0%	
	3.3	-2.3	.1	-.9	-.3	
	1.4	-1.3	.1	-.7	-.5	
	2.1	-1.6	.1	-.8	-.5	
6.00 bal.id.occ.part	6	3	5	0	0	14
	6.6	3.8	1.0	2.2	.3	14.7%
	42.9%	21.4%	35.7%	.0%	.0%	
	13.3%	11.5%	71.4%	.0%	.0%	
	6.3%	3.2%	5.3%	.0%	.0%	
	-.6	-.8	4.0	-2.2	-.3	
	-.2	-.4	3.9	-1.5	-.5	
	-.4	-.5	4.4	-1.8	-.6	
7.00 bal.id.integ.emo	0	2	0	1	0	3
	1.4	.8	.2	.5	.1	3.2%
	.0%	66.7%	.0%	33.3%	.0%	
	.0%	7.7%	.0%	6.7%	.0%	
	.0%	2.1%	.0%	1.1%	.0%	
	-1.4	1.2	-.2	.5	-.1	
	-1.2	1.3	-.5	.8	-.3	
	-1.7	1.6	-.5	.8	-.3	
10.00	12	4	1	8	1	26
	12.3	7.1	1.9	4.1	.5	27.4%
	[illegible]	15.4%	3.8%	[illegible]	3.8%	
	[illegible]	15.4%	14.3%	[illegible]	50.0%	
	12.6%	4.2%	1.1%	8.4%	1.1%	
	-.3	-3.1	-.9	3.9	.5	
	-.1	-1.7	-.7	1.7	.6	
	-.1	-1.6	-.8	2.5	.7	

LEARNING ASSUMPTIONS BY CLASSROOM ACTIVITIES

CLASSROOM ACTIVITIES

COUNT / EXP VAL / ROW PCT / COL PCT / TOT PCT / RESIDUAL / STD RES / ADJ RES

LEARNING ASSUMPTIONS	teacher-teacher 1.00	teacher-pupil 2.00	pupil-teacher 3.00	pupil-pupil 4.00	10.00	ROW TOTAL
1.00 cognitive	12	11	0	3	0	26
	12.3	7.1	1.9	4.1	.5	27.4%
	46.2%	42.3%	.0%	11.5%	.0%	
	26.7%	42.3%	.0%	20.0%	.0%	
	12.6%	11.6%	.0%	3.2%	.0%	
	-.3	3.9	-1.9	-1.1	-.5	
	-.1	1.5	-1.4	-.5	-.7	
	-.1	2.0	-1.7	-.7	-.9	
2.00 behaviour.	6	2	2	1	0	11
	5.2	3.0	.8	1.7	.2	11.6%
	54.5%	18.2%	18.2%	9.1%	.0%	
	13.3%	7.7%	28.6%	6.7%	.0%	
	6.3%	2.1%	2.1%	1.1%	.0%	
	.8	-1.0	1.2	-.7	-.2	
	.3	-.6	1.3	-.6	-.5	
	.5	-.7	1.5	-.6	-.5	
3.00 phenomen.	3	4	3	6	0	16
	7.6	4.4	1.2	2.5	.3	16.8%
	18.8%	25.0%	18.8%	37.5%	.0%	
	6.7%	15.4%	42.9%	40.0%	.0%	
	3.2%	4.2%	3.2%	6.3%	.0%	
	-4.6	-.4	1.8	3.5	-.3	
	-1.7	-.2	1.7	2.2	-.6	
	-2.5	-.2	1.9	2.6	-.6	
10.00	24	9	2	5	2	42
	17.9	11.5	3.1	6.6	.9	44.2%
	57.1%	21.4%	4.8%	11.9%	4.8%	
	53.3%	34.6%	28.6%	33.3%	100.0%	
	25.3%	9.5%	2.1%	5.3%	2.1%	
	4.1	-2.5	-1.1	-1.6	1.1	
	.9	-.7	-.6	-.6	1.2	
	1.7	-1.2	-.9	-.9	1.6	
COLUMN TOTAL	45	26	7	15	2	95
	47.4%	27.4%	7.4%	15.8%	2.1%	100.0%

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
21.94816	12	0.0381	0.232	13 OF 20 (65.0%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.27751	
CONTINGENCY COEFFICIENT	0.43321	

WITH LEARNING ASSUMPTIONS

WITH CLASSROOM AC

Appendix 3: Some aspects of the statistical basis of the interpretation of correlations.

In this Appendix, the rationale and some of the more "technical" (in the statistical sense) aspects of the study of correlations will be briefly discussed. As already noted, in this analysis the detection and interpretation of correlations between the various themes of the research instrument are based on the size of both chi square and of standardised residuals. Thus, the size of chi square (taking into account the degrees of freedom of the particular table) serves as a means to detect the existence of a correlation. The strength of the correlation is measured in this study by Cramer's V coefficient, for reasons which have been explained in the relevant section.

The essential element of chi square measures and subsequent attempts to interpret the correlations (if any) is one based on the differences between the observed frequencies and those frequencies calculated if one assumes a no association model (expected frequencies). The expected frequency for each cell is the product of the margin totals (sum of column and row for the particular cell) divided by the sum of all frequencies (i.e. the number of subjects in the study).

The square of the standardised residual for a cell in a contingency table can be obtained if one takes the square of the difference between the observed and the expected frequency for this cell divided by the expected frequency (formula A: $sr^2 = \frac{(f_o - f_e)^2}{f_e}$) [1]. The standardised residual for a cell shows therefore the difference between observed and expected value for this cell, in terms of the standard error of the expected frequency.

However, for counted data (as opposed to continuous variables), chi square equals to the sum (for every cell) of the quantity expressed as the square of the difference between the observed and the expected frequency for this cell divided by the expected frequency (formula B: $\chi^2 = \Sigma\frac{(f_o - f_e)^2}{f_e}$) [2]. For a more precise definition one should add that the limit of chi square is equal to the limit of the above sum when the limit of the expected frequency tends to the infinite. For this reason in the case of small expected frequencies - below 5 for tables with high degrees of freedom, as Blalock and others suggest, Yate's correction is usually recommended [3].

It is clear then that the sum of the squares of standardised residuals provides a good approximation of the chi square for a contingency table. Furthermore, taking into account the above formulae (A) and (B), it becomes evident that cells with large standardised residuals contribute most to the size of chi square, thus being responsible (that is to say the sources) for the existence of the correlation between the variables represented by the dimensions of the table. Therefore, if one establishes the existence of correlations on the basis of chi square, a very meaningful way to interpet these correlations is to look at the size of standardised residuals for each cell.

If we now consider, as noted above, that the standardised residual for a cell shows the difference between observed and expected value for this cell, in terms of the standard error of the expected frequency it also becomes clear that standardised residuals with values between 1 and 2 (or, -2 and -1) indicate a very considerable standard deviation of the observed from the expected frequency, while for values of standardised residuals higher than 2 (or lower than -2) the effect of such cells on the overall correlation is very significant. For this reason standardised residuals were categorised in the correlation tables studied here in terms of the above values (see section VIII.7).

The last point to be discussed refers to Yate's correction. The statistical package used in this study (SPSSx) has not a built-in sub-routine for calculating chi square corrected according to Yate, if low expected frequencies occur. Apart from this Blalock does not recommend Yate's correction for tables which have many degrees of freedom [4]. Almost all the contingency tables studied for correlations have more than 15 degrees of freedom. In such cases Blalock suggests that rows and columns should be omitted so as to construct smaller tables with no more than 2 or 3 cells having expected frequencies lower than 5. Then one can carry out chi square tests for these smaller tables so as to check again the existence of correlations indicated by similar tests for the complete tables. If the existence of correlations is verified one should return to the initial complete tables for the interpretation so as to avoid loss of information [5]. This procedure was applied in this study. The outcome is as follows:

-1st set of tests (complete tables - see Appendix 2): Out of 45 tables for 35 tables a significant correlation at the level of at least 0.05 was detected (see table T8.38).

-2nd set of tests (tables with no more than 3 cells with expected frequencies lower than 5): Out of the 35 tables for which a significant correlation was detected only 3 tables failed at the 0.05 (or lower) level. However, even for these tables, namely those concerning the pair of themes: sc. methodology-integration of sc. curricula, sc. methodology-assumptions about instruction and finally sc. methodology-assumptions about classroom activities) a correlation at the level of significance 0.12 (a weak indication for the existence of correlations) was found to exist.

Since the second set of tests showed virtually no difference compared with the results of the first set of test the attempt to interpret correlations was conducted on the basis of the complete tables for which the first set of tests revealed a significant correlation.

Bibliographical notes.

[1]. Blalock, H. M. (1979), p. 183.
[2]. Ibid., H. M. (1979), p. 281.
[3]. Ibid., p. 291.; Guildford, J. P. and Fruchter, B. (1981), p. 202.
[4]. Blalock, H. M. (1979), pp. 290-292.
[5]. Ibid.